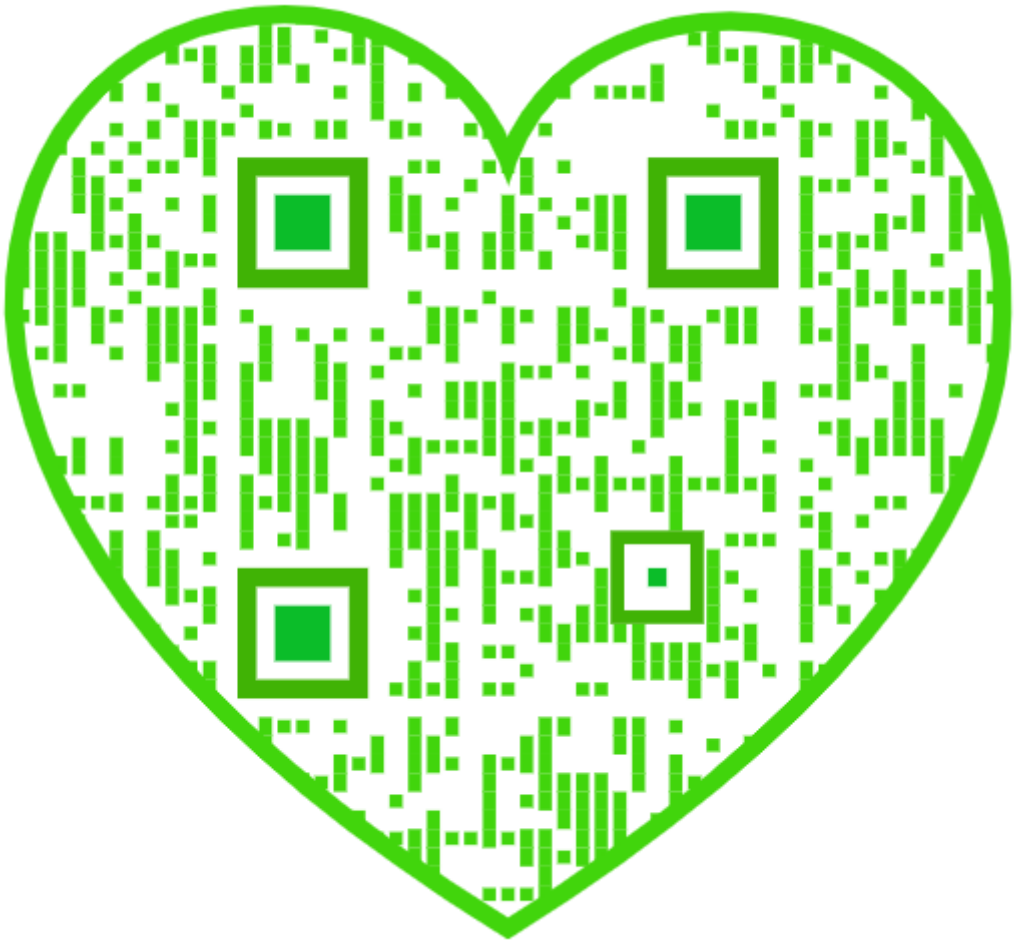

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RAISE POTATOES AND HELP TO WIN THE WAR

POTATO CULTURE

HOW, WHEN, WHERE AND WHAT TO PLANT.
CULTIVATING, SPRAYING, HARVESTING,
STORING AND MARKETING THE CROP

An Abridged Edition of Bulletin No. 190
Department of Agriculture
Commonwealth of Pennsylvania

PENNSYLVANIA SYSTEM

Edited by E. A. ROGERS, Brunswick, Maine

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Lawrence Anderson
1915

RAISE POTATOES AND HELP TO WIN THE WAR

One of the most important military duties that will rest upon the people of the United States, in the conduct of the War, will be to produce a surplus of food. We must have enough not only to meet our own proper needs at home, but also to aid in feeding the armies and the civil populations of the countries of Europe with whom we have cast our lot.

President Wilson, in his recent appeal, emphasized this fact by declaring that upon the tillers of the soil "in large measure rests the fate of the War and the fate of the Nations."

This booklet is issued by the Pennsylvania Railroad Company to assist and encourage the people whom its lines serve in extending, as greatly as possible, the production of one of the most important of the World's great food crops—**POTATOES.**

Potatoes are eaten universally. They are healthful, sustaining and satisfying, and they have the very great advantage that, if proper methods of cultivation are followed, enormous yields are obtainable from a given area of ground. From 300 to 500 bushels can be raised from a single acre by care and skill.

Potatoes are, therefore, particularly adapted to meeting the emergency created by the scarcity of food resultant upon the war.

All Americans, who can, should raise potatoes this Summer. Every potato produced before next Fall will be more effective, in the cause of the United States and the Allies, than a bullet.

Copies of this booklet may be obtained free from any Station Agent or Division Freight Agent of the Pennsylvania Railroad Company, or from the Freight Traffic Department, Broad Street Station, Philadelphia.

CONTENTS

	PAGE
Announcement	1
Foreword	3
General Conditions	5
Rotation	5
Selection of Suitable Soil	6
Underdrainage	7
Preparation of Soil	8
Humus	9
Causes of the Running Out of the Potato	13
Potatoes for Seed	16
Varieties	21
Originating New Varieties	21
Whole Potatoes for Seed	24
Sprouting or Budding Seed Potatoes	26
Selecting and Cutting Seed	27
Planting Early Potatoes in a Small Way	30
Planting Early Potatoes in a Large Way	35
Planting the Late or Main Crop	39
Stable Manure	41
Commercial Fertilizer	41
Cultivating the Crop	45
Insecticides	49
Paris Green	49
Arsenate of Lead	52
Bug Death	53
Bordeaux Mixture	54
Sprayers	57
Spraying	60
Insects	64
The Flea Beetle	64
The Colorado Beetle	66
Scab	67
Late Blight or Rot	70
Harvesting and Storing	74
Marketing the Crop	77

FOREWORD

This booklet has been prepared and edited especially for distribution by the Pennsylvania Railroad. As it is a condensation of the Special Bulletin upon potato culture issued by the Department of Agriculture of the Commonwealth of Pennsylvania, it is authoritative. Its pages set forth the actual results obtained by scientists and practical growers in successfully producing this valuable crop, and in obtaining large and increasing yields per acre.

The directions herein given, if intelligently and faithfully followed, will not only act as a guide to the professional farmer in taking up potato growing, or in improving his methods and enlarging his crop, but will also enable persons engaged in other pursuits to utilize any tract of reasonably fertile land in a manner that will help the Nation and the cause to which we are committed.

While the booklet deals particularly with potato culture in Pennsylvania, it is equally applicable to the other States traversed by the Pennsylvania Railroad, in all of which similar varieties of climate and soil are found.

Showing Ideal Foliage not Injured by either Insects, Blight, or Arsenical Poisoning

GENERAL CONDITIONS.—Pennsylvania, with its diversified soils, has many sections peculiarly adapted to potato growing. The culture of this important crop has not received the attention deserved, for there are few crops grown that so quickly respond to intelligent culture as this. The crop value per acre ranks highest where it is studied and modern methods and machinery used. This the statistics of the U. S. Department of Agriculture prove, Pennsylvania's standing among potato states being third in acreage and seventh in yield per acre, while Maine's is seventh in acreage and first in yield per acre.

That this is not wholly the result of better climatic and soil conditions in Maine is supported by evidence of crops in Pennsylvania yielding 300 to over 500 bushels per acre. If individuals can obtain such yields by proper methods, there is apparently no reason why the same effort, if put forth by other growers, should not increase the yield per acre in Pennsylvania to that of Maine.

ROTATION.—The grower must have a fixed system of crop rotation to obtain the best results, and this must be varied in different localities.

The Maine grower has a three or four year rotation:

First. Potatoes on broken sod.

Second. Grain, usually oats or spring wheat, sown as early as the ground is in condition to properly work, grass and clover being sown with either.

Third and fourth years hay, unless a three year rotation is practiced, when hay will only be cut the third year, plowing under the second crop of clover for potatoes.

This is varied by planting corn the second year, seeding to grass and clover at the last working of the corn.

As fine a stand of grass and clover is usually obtained by seeding in this manner as is obtainable by seeding with any system of small grains. There is a disadvantage, in that the first year's hay contains more or less corn stubble. This is unobjectionable if the hay be fed on the farm and not intended for market.

Following potatoes with corn permits the use of manure dressing on land in the potato rotation with little injury to the potato crop, as the manure will be so far consumed by the corn and hay crops before potatoes again come in, that the risk of rot or scab is slight. The manure will help both corn and the newly seeded grass and clover. If oats are sown, it won't do to apply manure, as its application results in lodged grain, which kills the clover, while lodged grain fails to fill.

This rotation should do as well in sections of Pennsylvania as in Maine, but in localities where corn is planted on sod, followed the second year with potatoes, crimson clover or some other humus supplying crop must be sown in the corn, if large crops of potatoes are expected. No system of rotation placing potatoes second will yield maximum crops.

SELECTION OF SUITABLE SOIL.—The soil must be well drained. No care in selecting seed and cultivation or surface drainage after planting will otherwise avail and a paying crop cannot be produced in soil filled with stagnant water. Deep sandy or gravelly loams are best. Not only will the potato, as a rule, grow better in this soil, but it is more easily worked.

The successful grower knows that it is then a question of doing work at the proper time, and that the soil referred to, can be worked sooner after our short summer rains, and little working delay need occur with such soil.

Clay loam, if not too heavy, will produce as much per acre as lighter soils and of just as good quality, provided the soil is well drained. The disadvantage of the heavier soils is in working them in wet weather, which may delay planting in spring and prevent cultivation to such an extent that weeds may get a start not to be overcome with any system of cultivation, except hand work, too costly and slow for our high priced labor.

Large yields of 500 to 600 bushels per acre and of finest quality have been grown on clay loam. Tillers of such need not despair of competing with those having an easily worked loam.

UNDERDRAINAGE.—The value of underdrainage cannot be overestimated. The cost of a system of tile underdrain has been more than repaid by increase in the first year's crop. A properly laid system will last a lifetime. and because of its beneficial effects on all crops of subsequent years becomes a profitable investment. This applies especially to places which are springy or with depressions in them or where water stands after rain. Such places will not produce a paying crop, regardless of any care given, until such surplus water is removed by underdrains.

The increase derived from this, represents only part of the value to the grower, since where water collects and stands after rain, the vigor of the crop is reduced or the plant killed outright, while blight often starts

there, spreads to higher parts of the field and ruin results, whereas but for this source of infection it would have escaped. Hence, an undrained sag in a potato field is a menace to the whole, for it is the breeding place for blight or rot, and even in a dry season when potatoes can grow in such a place they are seldom fit for market, usually being rough, illshapen and of poor quality.

PREPARATION OF SOIL.—To the average grower, the preparation is of more importance than the kind of soil, provided it be well drained. We have little workable land which cannot, under intelligent methods, produce a profitable crop. Land too wet needs drainage, land naturally too dry can, by supplying it with plenty of humus or vegetable matter, be made to hold moisture and produce a paying crop. With this, more than with any other crop, success depends on the man rather than on the soil itself.

Potatoes require much moisture; not stagnant water, which excludes air, but moisture in a form that permits air to circulate freely through the few inches of top soil, and the more vegetable matter or humus in the soil, the more moisture it can retain and still permit free air circulation. No crop so rapidly consumes vegetable matter or humus as this, and the more the soil contains the greater the yield.

The lack of humus in our soils is the greatest drawback to the grower today. Planting corn on sod, followed next year with potatoes, deprives the potato of the very vegetable matter it needs, while the growers' great problem is, how to supply this vegetable matter at minimum cost. In sections where crimson clover can be sown at the last working of corn, with a fair

prospect of good growth, it will prove of benefit, but in sections where corn is not much grown, the same system of culture and rotation as practiced in Maine can be followed with slight variations.

On old meadows, covered with heavy sod, will be found vegetable matter enough to produce a large crop, when a liberal application of commercial fertilizer is added. Such a field should be plowed in the fall, since by so doing the sod decomposes enough for capillary tubers to form and allow the subsoil moisture to come near enough the surface to be available for the potato roots. This does not occur when spring plowed, if followed by a dry summer. Land should not, however, be left without a cover crop during winter, as this results in waste of fertility. Rye, or a similar crop, should be fall sown, especially in sections where little snow prevails. The ideal method is, to harrow plowed sod both ways of the field in early August, using a weighted cutaway, followed with a spring tooth harrow. This will cut and pulverize the sod. Do this during a period of say four to six weeks, harrowing once a week. This rids the soil of undesirable vegetation and weeds. When sod has been thus reduced with harrow, plow and sow with some cover crop. Winter vetch and rye produce much vegetable matter to plow under in the spring, and will supply enough nitrogen to partly pay for the work. While the most costly method, it is the most profitable. Working the sod, as suggested, produces an ideal seed bed for the cover crop, and spring turning fills the soil with vegetable matter and puts it in the best condition to retain moisture and produce a crop.

HUMUS.—Control of moisture in land planted in potatoes is important and is not secured by drainage

alone, but is dependent upon the humus-content in the soil. Twenty-two pounds of water is required to saturate 100 pounds of clean dry sand; 56 pounds of water to saturate 100 pounds of perfectly dry, ordinary clay loam, while it requires 196 pounds of water to saturate 100 pounds of perfectly dry leaf mold, or nearly nine times as much as an equal weight of sand and three and one-half times as much more than is required to saturate ordinary clay loam. A soil deficient in humus will not produce a paying crop in dry seasons, regardless of the amount of cultivation or commercial fertilizer expended upon it, while a soil filled with humus can, by cultivation, be made to do so in a season devoid of rain. A clay loam soil filled with humus can be worked quicker after a heavy rain than like soil deficient in it, and the capacity of the humus filled soil to hold moisture is so much greater, that with intelligent, shallow cultivation a good crop is assured.

Control of moisture is not the only advantage of a soil filled with humus. The rock formed soils of the eastern United States are filled with mineral plant food. Leading scientists claim that the first eight inches of our heaviest loams contain enough potash for maximum crops for from 200 to 400 years and phosphoric acid enough for from 150 to 300 years, but this mineral plant food is locked up in insoluble form; a wise provision which prevents man from reducing the face of nature to a barren waste. Fill a soil with humus, which is decaying organic matter, and the acids formed in this process will help to break down and set free some of this insoluble plant food. The second eight inches of soil contain as much or more mineral plant food as the first.

The productiveness of our soils depends more largely upon their humus-content than upon any other one thing, and hence the first object of the potato grower should be to fill his soil with this decaying vegetable matter. To replenish the organic content of soil, bear in mind plants which will supply nitrogen, this being the most costly element of plant food to buy, and both humus and nitrogen can be supplied to soil by the legumes. Of these, alfalfa stands first, but because of the short rotation followed by potato growers, it is little used. Those having land enough to adopt a five year rotation for potatoes and facilities for keeping live stock to consume the alfalfa will obtain better returns. Alfalfa makes a large root growth, penetrating deeply even hard clay subsoil, drawing fertility from below, increasing the water holding capacity of the soil and at the same time gathering and storing nitrogen. None of the clovers have the elevating capacity of alfalfa, and the grower having a three-year-old alfalfa soil to plow under can grow a good crop with the smallest amount of commercial fertilizer. Alfalfa can be grown on any well drained soil, and, thriving best when sown in early August, can follow early potatoes. Properly seeded in properly prepared soil, no trouble will be experienced in obtaining a stand of alfalfa which will last three years, produce a large amount of hay and put the soil in best condition for potatoes.

Next to alfalfa, a heavy clover sod to plow under not only furnishes a large amount of vegetable matter, but many dollars' worth of nitrogen food. Authorities claim, that the second crop of clover leaves in an acre from 150 to 200 pounds of nitrogen, which, at present

prices, amounts to from $27.00 to $40.00 in nitrogen, and the mechanical effect of plowing under this second crop of clover sod, while not as great as with alfalfa, will be worth as much as the nitrogen to the potato grower.

In many sections, clover does not grow as well as it once did, and because of this, many farmers have stopped it in their rotation, resulting in great loss in the productivity of their farms. Experience teaches that the two main causes for failure of clover to grow are:

First.—The lack of lime; clover needs much lime, and unless this is present in the soil the bacteria existing on clover roots, and which gathers nitrogen from the air for plant use, cannot live or do not develop to the extent of being of much use to the clover crop.

Second.—If, after using lime, clover fails to grow, we may conclude that phosphoric acid is the one thing lacking to obtain the bountiful crops of the past.

The potato grower cannot succeed without alfalfa or clover. If the field to be planted is devoid of either of these, use winter vetch and rye as a substitute. They can be sown together in autumn, early enough to become established before winter. Sow two pounds of vetch to one of rye. Both make early growth in spring and produce a large amount to plow under for the crop. The vetch contains some nitrogen, which becomes available for the crop later on. This is not practicable for very early potatoes, as they are planted long before rye and vetch make growth of material value, but for later or main crop, where clover or alfalfa cannot be had, will prove a great aid in supplying both humus and nitrogen.

While clover sod is the best to plow down for potatoes, a good timothy sod, properly handled, is not to be

despised. Plow in the fall. Winter rains will pack the soil and cause a more thorough rotting of sod in time for the plants to feed upon it. This requires much work in spring with the harrow, previous to planting, for the soil is seldom worked deep enough for the best results. A better method, and one which has given fine results, is, instead of plowing the sod in the fall, work it up with the disc harrow to the depth of five or six inches, then if packed to any extent by winter rains, harrow once or twice in the spring; then plow and harrow and thus have the whole depth plowed, thoroughly pulverized, and the worked up sod mixed through it, puts it in the best condition for the crop. Timothy sod prepared in this thorough manner is better than a good clover sod half worked, and nicer potatoes will be produced than from clover, but not as cheaply, owing to the extra labor involved and the higher nitrogen content required, in the fertilizer used.

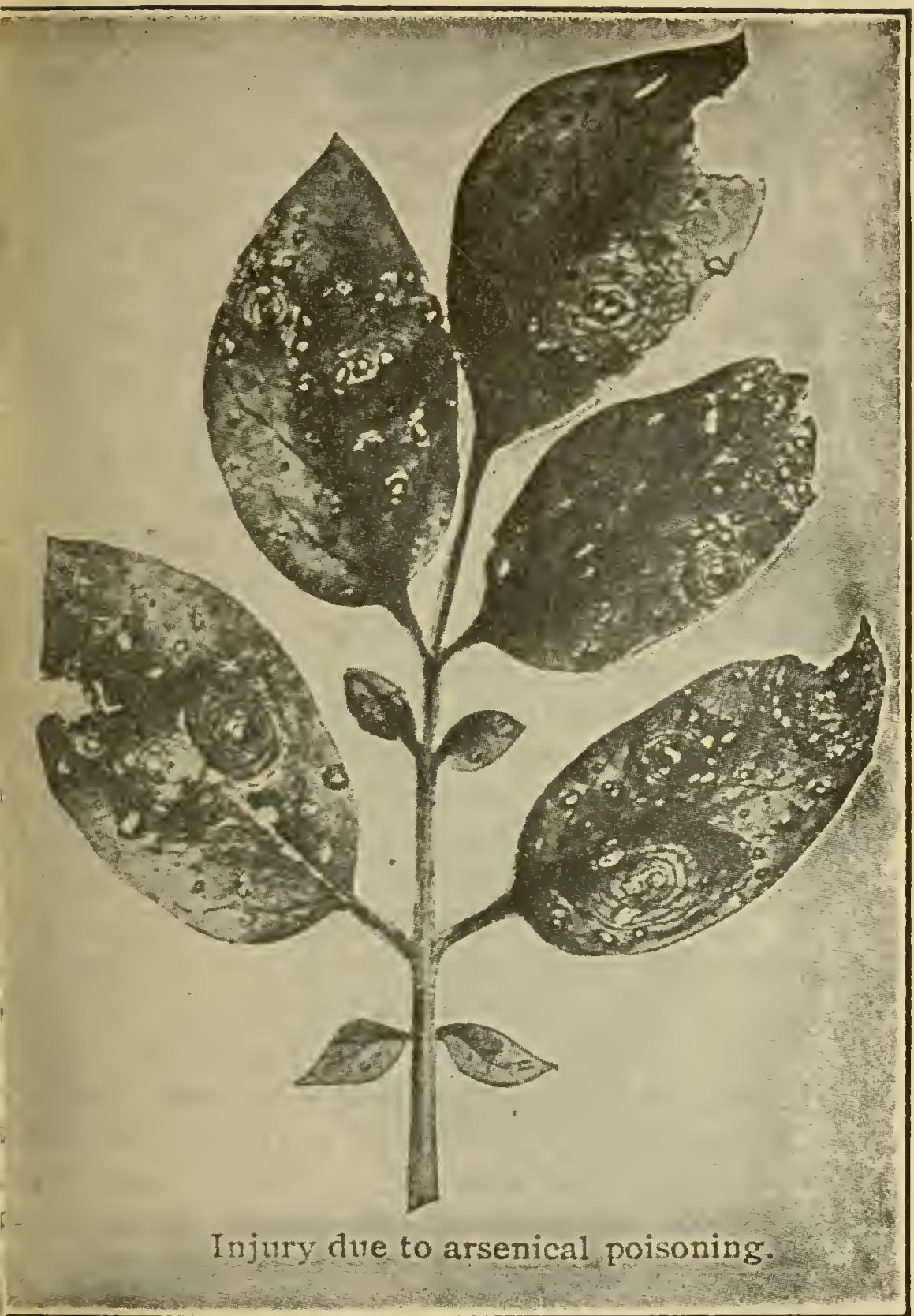
CAUSES OF THE RUNNING OUT OF THE POTATO.— Within the memory of living man all that was required to raise an abundant crop was to plant; no matter how, so long as soil covered the seed. Methods of culture which produced large crops then, if followed to-day, would not pay for the seed. The vigor of the tuber in those days not only produced an abundant crop, but its true seed, often under the worst methods. The decline of this vigor, dates from the advent east, of the Colorado potato beetle; the injury it did in stripping the vines of leaves was one of the prime causes of this loss; another and greater was the use of Paris Green to kill the pest. These two, one destroying foliage entirely and the other poisoning the plant

by absorbing arsenic, acting continuously on the easte
crop, did incalculable damage to the vigor of the potat
So much has this been impaired, that few of t
present generation have ever seen a potato boll, t
true seed of the plant, the plants no longer possessi
vitality enough to produce a crop and the seed b
also.

The habit of producing seed bolls is more pronounc
in some varieties than others. Some possess gre
vigor, but little in producing tubers of good quali
that grow seed bolls. Yet these are of little use
the grower. Again, many of the best varieties in poi
of yield and quality will, if given proper culture a
protection, which will not in itself injure the vin
produce many seed bolls. Within the past ten yea
seed bolls in more or less abundance have been pick
from varieties of best quality and largest in yie
New varieties have been brought forward, many
great promise and vigor, only to soon run out, chie
from causes shown, but helped in minor ways.

Farmers saved and planted only culls; these yield
good results years ago before the bug and pois
destroyed old-time vitality, but they rarely give
paying crop today. This is true of many older var
ties, which have so far lost their vitality that it
useless to endeavor to bring them back to productivi
equal to some of the newer varieties. Thousands a
today planting potatoes so low in vitality that
raise a paying crop under any system of cultivati
and protection, even in favorable seasons, is impossib

The remedy in northern states is, to obtain sor
newer strain, make careful selection each year from t
best and most vigorous hills and safeguard these



Injury due to arsenical poisoning.

a system of protection against insects and blight that will not in itself destroy the vitality of the plants.

A general effort is manifest of late to obtain a potat of large yielding capacity and good quality and bligh resisting, but with little success, doubtless becaus those performing the work failed to realize the deadl influence arsenical poisons have on plant vitality.

If a blight proof potato is ever found, it will b developed upon lines eliminating all possibility c arsenical poisoning or insect injury, because it is impos sible to produce it under methods which each yea saps to greater or less extent original vitality. Ther is little hope of a seedling from the seed boll of plant whose vitality has been impaired by arsenical poisoning or which will develop vigor enough to be blight proo unless the plant producing the seed boll has behin it years of unimpaired vigor, never obtainable insect injury or arsenical poisoning has existed.

The orchardist of Colorado knows that Paris Gree not only poisoned and killed his trees, but poisone his land as well. If potatoes today possessed the vigo they had before Paris Green was used, it is believe that under present-day methods of culture and fertil zation, the yield would be double the present average

POTATOES FOR SEED.—Seed of strong vitality i vital to success. The loss from poor seed is c startling proportions. Many have abandoned plant ing, believing their land unsuited to potato growing when successful growers on other soil would also hav failed with the same seed. Experiments prove, tha the seed used, largely governs the yield. No care ca produce good crops where the plants are weak. Failur is sometimes due to other causes, but the usual caus

is poor seed. The true seed comes from the boll, while the tuber itself is only an enlargement of the underground stem, and as such it partakes of the nature of the vine that produces it. If the vine be vigorous, with ability to resist disease, so will its tuber be, and if properly stored and planted will produce the same type of plant next season. "Like begets like," and if weak seed is used, weak vines will follow. Favorable conditions may produce a crop from such seed, but the fact remains that had good seed been planted on the same soil, under the same conditions, a larger yield would have resulted. Good seed is worth all it costs, but poor seed is dear at any price.

A practice prevails of planting second-sized potatoes, regardless of whether they come from vigorous hills or not. This is wrong. Seconds planted, year after year, only results in the early decline of the variety. Seconds are all right for seed, if selected from hills showing vigor of plant and liberal yield of good, large, marketable tubers other than the one or more second size which the hill contains.

The practice of hill seed selections at least every two or three years, should prevail and every year should yield better results. This involves extra labor, but not as much as the average grower surmises, and is worth many times the cost. The process is simple, and more uniformity can be had by limiting the selection to the one-stalk hills. This can be varied by adopting a standard of, say, not less than four good marketable potatoes to each hill of one stalk and not less than seven to each hill of two stalks, and ten to the three-stalk hill, each grown from a single seed piece. When the field for selection is from one-half to two-thirds ripened off, the grower,

armed with a bundle of sticks, goes systematically ove it and marks with a stick every hill found showing mor vigor than the rest, until hills enough are marked t supply seed for next season. Later, when the field ready to harvest, it should be gone over and the marke hills dug with a potato fork. Although vigor wa apparent at the time of marking, the marker was ignoran then as to whether or not those hills contained th requisite tubers. Not every vigorous hill has tube desirable for seed, either in number of tubers per hil size or quality.

Marked hills that produce less tubers per stalk tha the standard requires; any that vary in type from th original, or for other reasons, such as roughness c prongs, should be discarded. Selecting by this metho we obtain the following results:

First. Vigor, which is of prime importance, and l seed crop which withstood insects and blight withou injury. Again we have discarded the weak stoc which fungus disease attacks and which spreads an frequently destroys a whole planting. An entire cro has been lost at times by a few weak hills in a fiel affording breeding places for fungus disease.

Second. Seed obtained from hills that have pro duced the requisite number of marketable tubers thus safeguarding maximum crop results.

Third. Eliminating any tendency to sprout, a evil rampant in some of the best varieties, keepin the variety true to name, and stopping losses fron mixed seed, the bane of every grower.

The seed grower making selection in this manne for his own plantings obtains a crop certain to giv satisfaction to the purchaser intending to plant, an

hence the value of the product is increased. Experience proves that a single selection made in the manner suggested increased the yield the following year over 100 bushels per acre. This method, intelligently pursued, should obviate the necessity of purchasing other seed, and the yield per acre could soon be doubled without additional expense to the grower for seed.

In sections where it is not deemed necessary to obtain new seed each year, and where a new variety, or a new stock of an old variety from which to grow seed is desired, if unable to obtain seed grown from selected hills, then buy larger-sized potatoes of the variety wanted, smooth and free from disease. Accept nothing under a pound each of the medium late or main crop varieties. This weight is proof that the seed obtained has vigor, for no weak, sickly stalk ever produced a tuber weighing a pound. Planting these, hill selection can be made from hills producing the most tubers per hill in weight and number, and the purchaser thus obtains new seed possessing both vigor and productiveness at a minimum cost. In selecting seed stock upon this plan the size of tubers must be governed somewhat by the variety; for instance, with the "Green Mountain" or "Norcross," a tuber weighing a pound is not an overgrown one, for under favorable conditions this variety produces nice smooth tubers weighing two or two and one-half pounds, and the pound specimen may be only one of a half dozen grown on a single vigorous stalk, while a variety like the "Irish Cobbler," weighing from one-half to three-fourths of a pound, would indicate vigor, and is safe to plant and make hill selection from.

Grown on Pennsylvania Railroad Demonstration Farm. "Moneymaker" and "Irish Cobbler."
Planted April 5th, 1911—Dug July 8th, 1911.

VARIETIES.—It is vital that the grower obtain the variety suited to his locality. It is a common occurrence to see two varieties in the same field, both planted on the same day and receiving the same treatment, one yielding twice the marketable tubers produced by the other, and both being so similar in general appearance that an ordinary grower is unable to detect the difference, although one may mean financial success and the other loss. In sections where potatoes can be raised year after year without changing seed, the grower has a chance to test out new varieties and seldom suffers heavy loss. Where new seed must be bought each year by the large grower and the variety secured proves inferior for that section, the loss is heavy. Again, the grower to obtain the best returns from his crop, must conform to shape and color demanded by his market. As a rule, the large markets demand a round white potato with a shallow eye, and there are many such of fine quality. Some of the most palatable, largest yielding and blight resisting varieties known, will not sell well in the city markets, simply because the public select by color; but for the grower, who sells his crop to home customers, they possess value, since his crop, of any color and perhaps shape, probably controls the market, adds individuality and aids him to build up and retain a fine local trade.

ORIGINATING NEW VARIETIES.—Most new varieties are obtained by planting seed from the potato boll, formed from the plant's blossom. These bolls contain many seeds, each of which produces a different variety. The prospect of obtaining a new variety of value is greater, if care be exercised in growing the boll from

which the seed is taken. Some varieties, which grow coarse, ill-shapen tubers of poor quality, seem to exert their vitality in producing seed bolls. Varieties of this pedigree invariably develop the general characteristics of the parent stalk. Very few ever prove of value to the general grower.

To originate new varieties one of the best standard varieties should be selected and a proper system of culture and protection from insects and blight followed, to build up its vitality to the point where the plant produces bolls. This is easily done. Obtain seed bolls from a field containing only one variety of large yielding capacity, combined with very high quality and allow no other variety to be planted near them. Seed from such a source produces an increased per cent. of valuable varieties. Originating new varieties is of vital importance to the industry, and he who develops new seedlings superior to the older standard sorts, is worthy of praise and financial return. The new seedling may promise to be a great acquisition and prove good until three or four years old and then prove worthless in a single year. If the originator markets these as seed to repay him for his labor, the purchaser blames him, and his reputation suffers. If a new seedling proves good for seven or eight years, increasing in productivity and quality each year, the orginator may feel confident that he possesses something of merit and value. The proper way to test the new seedling is in general field culture, side by side, with the best superior variety to be had. The seedling tested should be at least two years old, but four or five years old is a truer measure of value. If yields prove larger than the superior variety, and quality

and other characteristics be equal or superior, and this result is obtained for two or more years, it is reasonably safe to push its sale. The grower, however, is warned not to invest largely in any new seedling until tested on his own farm in a small way; a variety that will do well in one section may fail in another. Every large grower, however, should test the new productions. There will be so many to discard, that no large sum should be invested in any one until tried and proven valuable.

Growing seedlings is interesting, and in the absence of a greenhouse to start them in, they can be started in a box in a warm sunny window. The box should be nearly filled with leaf mold soil, if possible to obtain it, but old rotted barnyard dressing two or three years old, will answer. Use none but the fine portion, however. Plant the last of March and cover very lightly with this soil and do not allow it to become dry. Allow the plants to remain in the box until three or four inches high when, if the weather and ground be warm, replant in a rich garden spot. They transplant as easily as a tomato. Set eighteen inches to two feet apart in a row and give good care the first season. Insects of many kinds devour these young plants unless protected. Allowed to grow the full season, the plants will produce some good-sized tubers the first year. These first year's seedlings sometimes weigh nearly a pound, but this is unusual, and most of them will only reach the size of walnuts. Each hill should be dug and kept separate. Probably three-fourths will be discarded at the time. Next season all selected for further trial should be planted, as before, in a garden spot where better attention and protection against

insects can be given, than is usually possible in the field. The second year more will be discarded, and of those preserved there should not be more than a peck of each. This is enough to test beside some superior variety in the field. If the seed came from the boll of a large yielding, fine quality variety, there should be one in every hundred plants worth saving. If, however, the seed is from a variety, the chief merit of which is that it will produce potato bolls in abundance, one in thousands worth saving is all the grower can anticipate, and he should be satisfied.

WHOLE POTATOES FOR SEED.—Planting small to medium-sized potatoes whole has occurred to every grower. The question is one that should be thoroughly understood, and the source from which the seed came be known in every case before planting.

Failure to do this will probably result in loss in crop yield; the size, condition and time when planted influences results. In testing the value of small-sized whole potatoes for seed, under certain conditions, there is no seed we can plant which will produce in yield and desirability the results obtainable from medium-sized potatoes planted whole. Small tubers planted whole should come from good, vigorous hills. This is important. They can be selected from the bin, provided they were grown from selected seed, where the whole field was vigorous and thrifty. If the field contained many spindling stalks or weak hills, the small potatoes grown there should never be planted. A good, vigorous hill seldom produces more than one or two tubers small enough to plant whole, and often there will not be one in several hills small enough for this purpose. The weak spindling stalks, without

vigor enough to produce large tubers, will invariably produce those of the size needed for planting whole. Hence, unless care is exercised, tubers largely from the weakest hills in the previous crop will be planted; and since "like begets like" the crop suffers.

The best size to use are those as large as a medium-sized hen's egg. Plant in rows three feet apart and set fourteen inches apart in the row. This size will require about twenty bushels per acre. If this size is planted in dormant condition, or before sprouts have started, there will usually be from one to three sprouts start from the seed end These start so much quicker and stronger than those from eyes nearer the stem end that they will exhaust the plant food contained in the tuber and no sprouts start from the other eyes. If tubers too large are used, the quick starting sprouts on the seed end will not exhaust all the plant food they contain, and many weak sprouts will start from the other eyes. These produce nothing of value and are worthless.

It is not desirable to plant too small a size even though coming from good vigorous hills, neither is it best to plant any whole potatoes after the eyes have started, as there will be too many stalks in a hill. This rule can be ignored in early potatoes where the side sprouts are broken off by hand, leaving only one or two of the best on the seed end.

The advantage of planting whole seed when they come from thrifty, vigorous hills is that they are certain to produce a perfect stand of plants regardless of the weather after planting. The vines grow faster and the crop matures one to two weeks ahead of cut seed planted at the same time and under the same conditions. The crop will be smoother and rounder than

usually obtained from cut seed. Why this is so, is not apparent. In planting whole seed, more fertilizer, if desired, can be used without injury to the seed, because there is no cut surface to come in contact with. There is also less injury to whole seed from wire worms, if present in the soil, than to cut seed.

SPROUTING OR BUDDING SEED POTATOES.—Time can be gained by budding or sprouting seed to be planted for early market, but this method is limited to small growers who have time for the work; to owners of small gardens, desiring early potatoes for their table, anything hastening early maturity is of value. While potatoes can be sprouted for later planting with the planter, the sprouts must not attain growth enough to be broken off in the machine, which will occur if the buds attain much growth, resulting in loss of vitality, as part of the plant food stored in the seed piece has been exhausted. The second sprouting being weaker than the first cannot, other things being equal, produce as many tubers as the first sprouting.

In starting sprouts for early hand planting, light and air, with reasonable warmth, are essential. The stronger the light, the shorter and greener the sprouts. For very early planting, start the sprouts in semi-darkness, so they will be a dark pink color, thick and stalky. These will push through the soil quicker than the short, dark green sprouts started in bright sunlight. Potatoes so sprouted should be planted before too far advanced, otherwise it will be impossible to cut and plant without breaking off the sprouts. A limited quantity for very early planting in the kitchen garden can be put in boxes, not over five or six inches deep, placed in the light, where heat is moderate, and

sprouted. Where a larger area is involved an available barn floor will do, provided light and warmth enough can be obtained, or they can be spread out of doors in a dry, warm, sunny place. In the latter case care must be taken to fully protect them from cold nights, as long as danger of freezing exists. Very early potatoes, being usually planted before late frosts cease, must be sprouted one to two weeks before planting; danger of sprouting out of doors so early is obvious.

If the sprouts are but slightly started, exposure to the light and heat of the sun softens and turns the tuber green, so, that in cutting, the action of the knife will be noiseless, and such tubers will come up quicker, even though the sprouts at planting show little growth. Perfectly kept potatoes are usually too hard to cut and plant at once. Cutting with an ordinary knife, with a comparatively thin blade back, cracks and breaks the tissues and injures the seed. If necessary to use seed in this condition, it is imperative that a very thin-bladed knife be used in cutting, to avoid injury to the tissues, although more difficult for the operator.

SELECTING AND CUTTING SEED.—Having selected a variety that thrives in his locality, the grower must select seed free of scab. Good, smooth tubers, of average size, will cut more uniformly, and this saves trouble if for use in the planter. It is more important, in using a planter that seed be cut to uniform size than that there be a given number of eyes to each piece. Hand-cutting, by one who knows how, is preferred to any cutting machine, which invariably mangles the seed and causes an uneven stand. For hand-cutting, the knife must be very thin, just as thin as it can be and stand the work. This enables the user

to cut more in a day, as he feels little resistance from the knife passing through the tuber, and the pieces will not be mangled.

In cutting potatoes large enough for over four pieces, it is better to first cut the tuber in half, and, if very large, into quarters. In cutting either into halves or quarters, cut above the eyes. The eyes of a potato have roots always running toward the stem end. These convey the plant food, the tuber contains, to the sprouts. If these roots are cut off close to the eye, while there may be a large piece above the eye or towards the seed end, the sprouts will not derive the food the piece contains, as it has no eye roots running towards that end of the tuber, hence it will not make as strong or thrifty a plant, or yield the tubers, it otherwise would. If the potato to be cut is a medium-sized one, or what is termed a good second, the stem end is cut off, cutting above at least one good eye and taking about one-third of the tuber. This usually allows from one to three or more good eyes on this stem end third of the tuber, even in a variety possessing but few eyes. The long cut is made by cutting from the upper or seed end down towards the stem end. This makes three pieces of a tuber of this size, and there will always be enough eyes on each and very evenly divided between the three pieces. It also has the advantage of having them of uniform size, which insures much better work with any planter. It being no more work to cut above the eye, and since the potatoes will then come up more vigorously, it is well to observe it. Plant in rows three feet apart and drop fourteen inches apart in the rows.

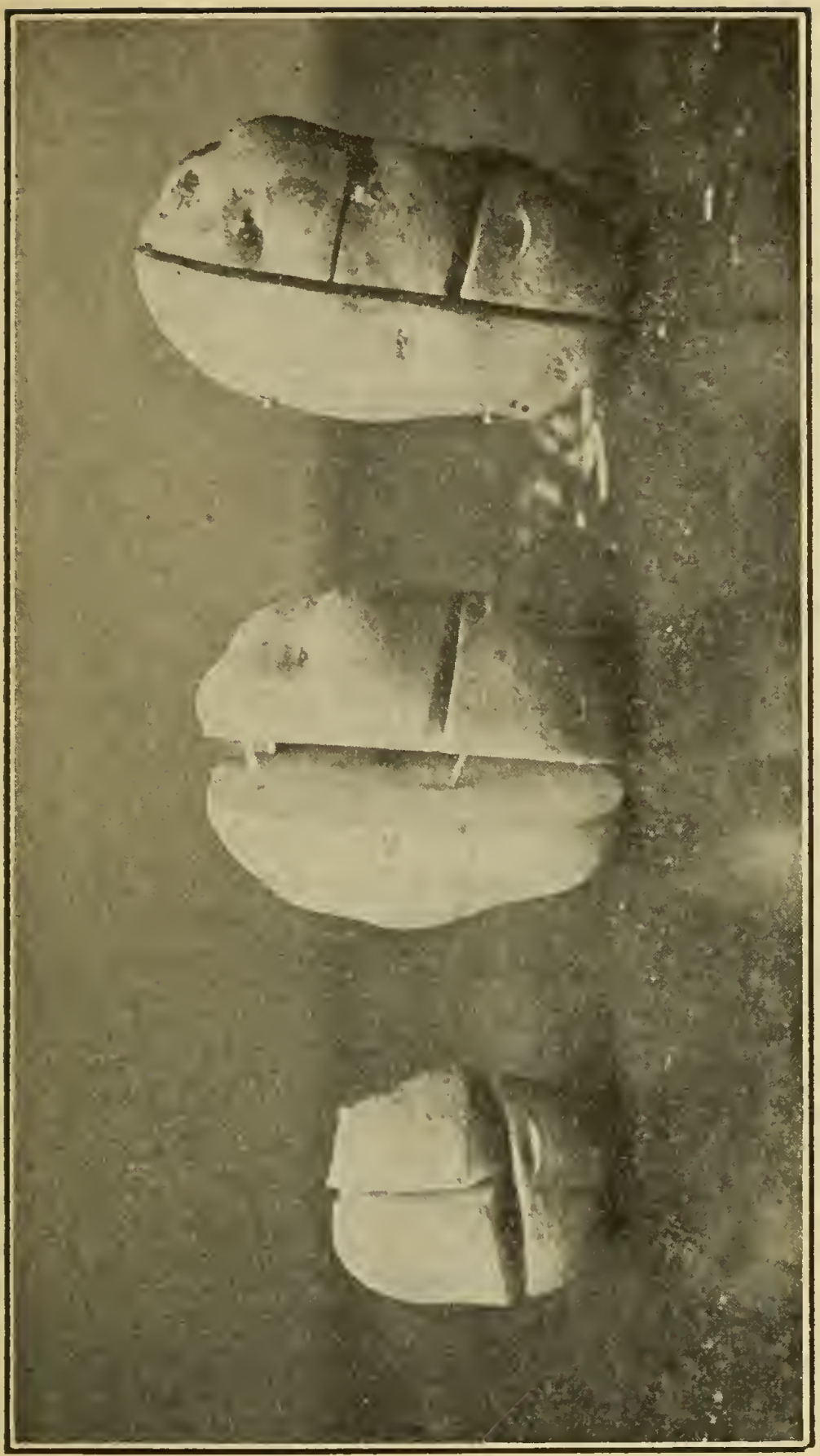
Cut seed must never remain in bags or piles. All

danger of heating must be avoided. Seed that is heated, even a very little, is unfit to plant, and if it comes up at all it is weak and spindling and beyond all possibility of growing a paying crop. The proper way to treat cut seed is, to sprinkle it liberally with land plaster (gypsum), as fast as cut. Be sure to cover all the cut surface with plaster. This keeps the seed cool and prevents drying out, and if spread out not over six inches deep until needed to plant will not hurt, even if cut a week or ten days before planting, provided it is kept in a cool, shady place. If fertilizer is used in planting, the land plaster also prevents it from coming in contact with the cut surface of the seed, which it might otherwise do, causing partial decay before the sprout starts, and frequently the total loss of the seed. This is more apt to take place when seed is planted as fast as cut, and experience proves that the best results come from seed cut twenty-four to forty-eight hours before planting and liberally sprinkled with land plaster when cut. It will pay to observe this rule.

The size of cut pieces has much to do with the vigor of the sprout, and a liberal piece should be allowed, especially if the weather is cold and wet at planting time. With rows three feet apart and pieces dropped fourteen inches in the row, twelve bushels of seed per acre is none too much, but if the weather is warmer and the soil warm and moist the seed can be cut finer, say to ten bushels per acre, and a good, vigorous stand result. Many growers clip the tip off the seed end of the tuber. There is nothing gained by this; in fact, it is often a distinct loss. The one or two eyes directly on the seed end of the tuber are the earliest

and most vigorous, and clipping these off, often deprives the grower of the strongest and best seed eyes. This may not be true of some varieties, but certainly is of the majority. The general belief of those who practice this is, that there will be so many stalks from the cluster of eyes at the seed end that there will be too many potatoes set to grow to good market size. This is not true of potatoes planted in a dormant condition, as one or two, usually one eye on the seed or tip end, will start so much quicker and stronger that all the plant food in the potato, if small or moderate-sized pieces, will be absorbed and the other eyes fail to grow.

PLANTING EARLY POTATOES IN A SMALL WAY.—Those who grow a few very early varieties for their table, and desire very early results, can expend more time, etc., than large growers. A few days gained, more than pays for the extra outlay to obtain results. A warm, sunny Southern, or better still Southeastern slope, on land little subject to late frosts, will, of course, be the best. It must be well fitted by deep plowing as soon as the frost is out and work can be done. Frequent working with the harrow, both to fine and lighten the soil as well as to warm it, will, if it can be done without too much cost, help gain a few extra days and thus prove profitable. Harrow just after the heat of the day, turning under top or warm soil and turning up colder soil beneath and repeated in a few days, if weather is warm, will increase warmth in a soil. A few extra degrees of heat gained then, means much to the early grower. When the soil is well fitted, furrows must be opened deeply, and for early varieties, a distance of from 26 to 34 inches between furrows is room enough. For extra early,



SHOWING METHOD OF CUTTING TUBERS

nothing will force a quick growth better than fine hen manure, it being rich in nitrogen. If the seed when cut is well sprinkled with land plaster and when planting sulphur is spread along the rows, little scab damage will result from the use of hen dressing when the crop is harvested early. Later on, when the potatoes have well started, some fertilizer containing an abundance of phosphoric acid and potash, to force tuber formation and growth, should be used. When hen manure is used it must be drilled along the furrow and mixed into the soil, so seed pieces when dropped will not come in direct contact with it. The same rule applies to commercial fertilizer. If necessary to use stable manure it will not harm seed to drop it upon the dressing. This is objectionable because o the labor in drilling the manure and the danger of scab. Rot seldom attacks very early potatoes.

The seed pieces should be dropped, say 15 inches apart in the row. It is a needless waste of time and labor to place seed with the sprouts up. Careful tests prove that if there is any difference in time of coming up, it favors pieces dropped with sprouts down. The first covering of this seed, while it depends somewhat on the nature of the soil, should be light, not over 1½ inches in the heavier and 2½ inches in the lighter soils; the rows must be deep enough so that, after covering the seed, a depression remains of two or three inches. If the seed has been well sprouted and carefully planted it will begin to break ground in from one to two weeks, according to weather. The depression in the rows must be gradually filled in as the plants grow. The weeder can be used if run lightly, but care must be taken not to break off

any sprouts from these early potatoes, as the time taken from the weakened seed pieces to force another sprout will make it so late, that, that hill will be worthless when the others are ready to dig, and might just as well have been destroyed.

If frost threatens, after the plants break ground, they should be buried with soil; this can be done quickly with the horse hoe, and if a depression exists along the row they can be buried quite deeply without making too much of a ridge, and when danger of frost is over the weeder can again be used to level the ground, thus killing all weeds started. This puts the field in condition to bury again if more frost threatens. Prior to this, however, fertilizer should be scattered along the rows, and covered about three inches by the second burying. This will not injure the plants, and one or two new sets of roots will start out around the stalk above this second application. If this fertilizer contains quite a per cent. of nitrogen, in the form of nitrate of soda, it will give the plant a very quick start, because at this period they have a well-developed root system. Nitrogen will not be much needed when hen manure has been used in planting, but a fertilizer containing a high per cent. of phosphoric acid and potash applied in the same manner would be highly beneficial. The point about early potatoes is, to get them up as soon as possible, so they can develop root growth, and still keep the tops small enough so they can be covered with soil at any time, if this protection from late frosts is required. With a well-developed root system and second application of fertilizer applied at just the right time, a crop can be produced that will catch the high prices of the early

market. Obviously this method cannot be used in large fields, where necessary to use the planter, but in a small way it has advantages. Well sprouted seed planted, and covered lightly at first opportunity, insures a perfect stand of plants. This will many times compensate for the cost of the extra labor involved.

Another method for the kitchen garden grower is, to take medium potatoes of about the size of a large hen's egg and sprout them as before described. At planting, break off all sprouts, leaving one or two of the best and strongest at the seed end. There will not then be one chance in a hundred of the seed rotting in the ground, no matter how cold or wet the weather may turn. Of all eyes on a potato, those on the seed end are earliest and strongest, and by removing all but one or two of these, the very earliest and most vigorous eyes remain. These having such a start, will absorb so much of the plant food the tuber contains that enough seldom remains to start any more stalks. Whole potatoes of the size described, planted whole in dormant condition, or before eyes have started, seldom produce an average of more than four stalks to each tuber. This is too many for best results with very early varieties, as the crop yield would be too numerous and too small in size. By breaking off all but two or three, or all but one, if large-sized tubers are wanted very early, there would be but one strong vigorous stalk to a hill, which will produce the desired result.

If the grower will take two bushels of medium tubers about hen's egg size and in dormant condition, cutting one bushel in halves, thirds or quarters, as best suits him, and plant the other bushel whole, sid

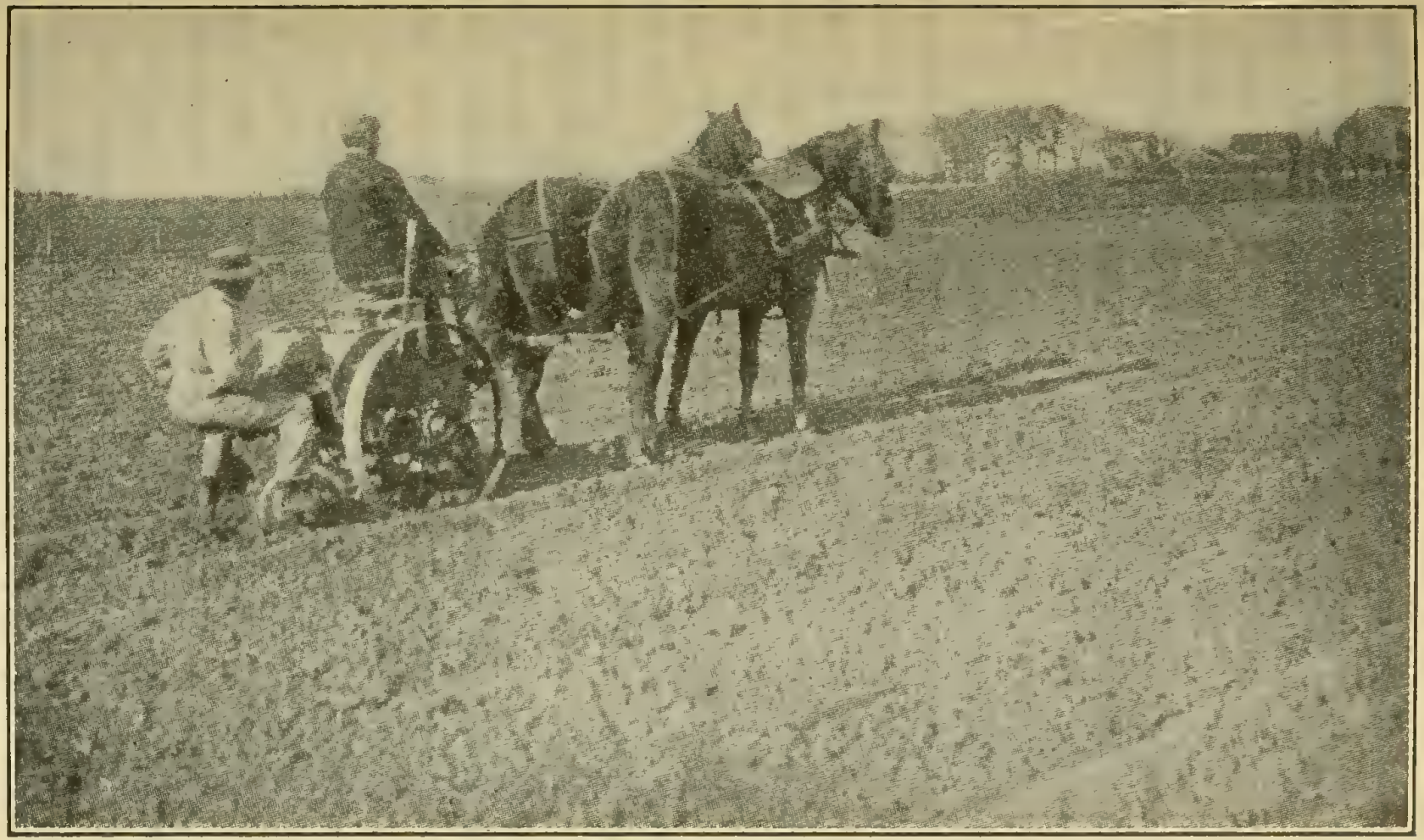
by side with the cut ones, at the same time and under same treatment, he will find those planted whole will mature from a week to ten days ahead of those cut. Cutting the tubers seems to delay maturing the crop. A tuber the size of a hen's egg sprouted, as it must be to get a very early start and planted whole, will, if all the eyes have gotten well started, produce a stalk from each eye or too many in a place, and to obtain earliest results from both sprouting and planting whole seed, we must break off all but one or two of the strongest sprouts, in planting medium-sized potatoes whole. This requires too much labor except for small growers.

PLANTING EARLY POTATOES IN A LARGE WAY.—Where the acreage is sufficient to require the use of the planter, the sprouts must not be allowed to advance as much as with tubers intended for hand-planting. But if an early crop is desired, much time can be gained by starting the sprouts in a warm, light place. The long, white sprouts which start in the cellar are useless and only sap the vitality of the tuber, causing the next set of sprouts to be weaker, and neither will produce the crop of tubers a first sprout properly started would. Seed must be kept in a cold, dark place, where the temperature is about thirty-five degrees, to obtain best results. A few weeks previous to planting remove them to a warm, light place, and spread where the sprouts will start. The sun should not shine directly upon potatoes about to be sprouted, for the very early crop to be planted in a small way by hand, as described under that head, but it is all right for those to be machine-planted. The sun will green and toughen the sprouts, and at the same time soften the tubers. Potatoes exposed to direct sunlight will sprout more slowly and will be

stouter and less liable to break off. In other words, direct sunlight puts the potato in better condition to sprout quickly when planted in suitable soil, while also starting them least before planting. Since seed which is to be run through a planter must not have the sprouts more than well started, because of the danger of them breaking off, this is a decided advantage.

Potatoes warmed and softened by the sun, with the sprouts just well showing in the eyes, will go forward and be from one to two weeks ahead of the same seed taken direct from storage, and, when cutting, also affords a chance to discard all tubers with impotent eyes and all in which sprouts fail to appear. This insures a much better stand of plants.

The ground should be well fitted to permit the planter to do its best work. The depth to plant early potatoes with the machine must, to a certain extent, be governed by local conditions. In sections where there is little danger of moisture becoming short early in the season, shallow planting can be done. The deeper they are covered, the longer the delay in coming up, and in many cases the weaker they will be. If the crop is desired as early as possible, they must not be covered over two inches below the surface, after the ridges which the machine left in planting are leveled off. This leveling should be done at once after planting. To insure all seed being covered an average of two inches deep after the surface has been leveled, the machine must be set so that there will be at least five inches of soil over the surface as the planter leaves the rows before leveling. The extra three inches of soil should be leveled off at once, as it prevents both air, light and warmth from penetrating to the seed, and



PLANTING THE CROP

delays growth and retards maturity many days. The top soil is the warmer in very early spring, but we must remember the fact, that as the season advances the deeper soil contains more moisture and is in better condition for growth of tubers than soil nearer the surface. Even early tubers must be rooted as deeply as possible, and when planted only two inches below the surface we have made as great a sacrifice for warmth and an early start as circumstances permit.

In planting early varieties do not use over 700 or 800 pounds of high-grade fertilizer per acre in the drill at planting time. Early varieties, as a rule, are not as vigorous as the later or main crop, and the amount of fertilizer that many times will not cause appreciable damage to the later kinds may do much injury to seed of an early variety. Rows of early varieties, with its smaller growth of vine, can be several inches closer together, most growers planting from twenty-six to thirty inches. In planting early potatoes, it is better to have fertilizer of two different formulas, one to have its nitrogen in a slower form than nitrate of soda, as it is usually several weeks before the plants have root growth enough to use it. Nitrate of soda is available over night when placed in a damp soil, and, in case of heavy rain previous to the potatoes breaking ground, be largely lost to the crop. When plants are well up so the rows can be plainly seen, the balance of the fertilizer should be applied. Experience proves that best results are obtained by applying this along the rows and by hilling the plants, covering them some three or more inches. This second application can have its nitrogen content largely in the form of nitrate of soda. The

plants will now have a large root system, and can use it, and it will cause them to make a very quick growth at this time. This is desirable, as the quicker the ground is covered with vines, the less moisture is lost by evaporation, and the more rapid the growth at this time the less real injury occurs by insects, notably that scourge to early potatoes, the flea beetle. The quicker vine growth can be obtained on early potatoes, the better, and there is no way in which to so rapidly push it, as by an application of fertilizer along the rows, containing its nitrogen in the form of nitrate of soda, after the plants have broken the ground and have formed a well developed root system.

PLANTING THE LATE OR MAIN CROP.—In this but little difference in the method is required from the machine-planted early crop. Seed should never be allowed to sprout in storage, as the sprouts are useless and result in great loss of vitality. When seed stock is found starting in storage, before it can be used, remove and spread it in the sunlight, but not over one deep. Potatoes that have begun to sprout will keep longer and in better condition to plant, when spread in direct sunlight than in any other way. If kept in cold storage, at a temperature too low to sprout, they require much more time to break ground than if warmed up a short time before planting. The ideal way to treat any intended for seed is to keep them at a temperature that prevents sprouting, and a short time before needed for planting, place them in the light and sun. Those for late or main crop, spread out thinly and expose to the sun's direct rays, just long enough to start the buds well. They can be spread out of doors on the grass, but it is more prudent to keep them in a building with

windows enough to admit plenty of sunlight; there is then no danger of injury by late frost. In cutting such potatoes, all weak-eyed ones can readily be detected and discarded. This would be impossible if cut as removed from storage. Seed handled in this way preserves its vitality for the sprouts which make the crop.

This one point in handling seed may make the difference between good profit and great loss. The method of cutting seed is described under that head. The planting of the late or main crop should be deeper than for the early. The general early crop is planted more shallow than the late because the ground is cold, and rot is likely to cause loss of seed if it is delayed in coming up by being planted as deeply as the later varieties. With the late or main crop, it is different, as planting is later and the soil warmed up, and being well prepared the machine must be set to drop the seed three inches deep, even in the heavier clay loams, and four inches is better in most soils adapted to potato growing. Use one-half the amount intended to be drilled at time of planting, or up to one-half ton of high grade fertilizer per acre. It is not advisable to use more than this, even on the vigorous late varieties, unless medium-sized whole potatoes are planted. In which event, as much as one ton of high-grade fertilizer per acre can be used with little harm to the seed, especially if the seed has been well started by exposure to light and sun.

Main crop varieties, which are usually of much larger vine growth, must be planted in rows wider apart than early kinds. The practice in Maine is from thirty-two to thirty-six inches and about fourteen inches

apart in the row. Some of the best late variety growers are forced to plant twelve inches in the row, to keep the size down to marketable demands. This may not prove necessary in many sections, where dry weather cuts the size down more than along the Maine coast.

STABLE MANURE.—This should rarely be used when planting potatoes, because of a tendency to cause scab and rot, and is only resorted to when land lacks humus or vegetable matter. The potato demands humus in the soil for best results, and only when it can be supplied in no other way is it wise to resort to manure just before planting.

The time to apply it to land for potatoes is just after the potato crop is removed, when, succeeding other crops, following in rotation, will leave the soil in such condition that when the same ground is used again for potatoes, little tendency to either scab or rot will remain. When applied to newly-seeded clover, after potatoes, it will aid in producing a perfect and vigorous stand of clover, thus insuring a good sod to plow under and furnishing vegetable matter for the next crop of tubers. A good crop of tubers free from scab and rot has been grown with an application of manure, but this is exceptional, and the safest way is to use this material in growing other farm crops.

COMMERCIAL FERTILIZER.—Probably no crop grown, where plant food in commercial fertilizer form must be bought, now yields so great an average profit as the potato, hence plant food in this form is much resorted to. Commercial fertilizer will not, however, supply the bacteria absolutely essential to soil productiveness, nor does it supply vegetable matter, also necessary for the bacteria in the soil to live and thrive on. Belief exists that liberal

use of strong potash salts, treated South Carolina Rock, and nitrate of soda, tend to kill the bacteria by direct contact with them in the soil. If repeated every year, without manure to create new bacteria, a few years only elapse until the soil, deprived of bacteria, refuses to produce any paying crop, regardless of the plant food it contains. It has lost bacteria; its mechanical condition and its water holding capacity; become heavy, inclined to bake after rains, and instead of a moist, lively look, appears dry and dead.

Those who cannot keep live stock can grow potatoes by using commercial fertilizer continuously and maintain the productivity of the soil, but if humus or vegetable matter is wanting maximum crops are remote. If, however, humus and bacteria are maintained, each year should reveal more and better crops.

All soils have plant food locked up in them, in varying degree, regardless of how exhausted they seem, and productivity is restored by the action of acids formed by decomposing vegetable matter, breaking down and making this available. Bacteria aids in decomposing vegetable matter forming these acids, which liberate this mineral food.

The potato grower's object in using commercia fertilizer wholly, is to get and maintain sufficient vegetable matter in his soil to obtain results from its application. The amount used per acre should not be governed by the amount the crop is assumed to remove. Hence, the most successful growers apply much more phosphoric acid and potash than any crop of tubers can consume. There are sections where little potash seems required, while phosphoric acid is needed in quantity, although the crop itself needs little of

the latter. This fact renders impossible any set formula for general use in making or selecting a suitable fertilizer for all soils or locations. This must be determined with due consideration as to what the crops, which follow, will need.

A 4–6–10 formula is more used in Maine than any other. This is stated, not as a guide for other growers but because in no section are exhausted, abandoned farms being brought to productivity so rapidly as there. This formula not only gives Maine the largest potato yield per acre produced in any State, but is adapted to its general rotation. That phosphoric acid and potash can be varied to suit different sections, and yield even better results than many growers now obtain, seems probable. As a general formula 4–6–10 will doubtless suit as many different soils as any, where crop rotation, potatoes included, is practiced and soil productivity is to be increased.

The amount of plant food removed from the soil by a crop of 300 bushels of potatoes is about 58 pounds of nitrogen, 27 pounds of phosphoric acid and 80 pounds of potash. As heat and cold, dry or wet weather affects the availability of the plant food in a fertilizer, we must apply much more potash and phosphoric acid than the crop consumes, to render available what the crop needs, at the time it needs it, to obtain the maximum yield. In sections where potato growing with commercial fertilizer is practiced the best farmers use a ton per acre of fertilizer of the 4–6–10 analysis. This means 200 pounds of potash, 120 pounds of phosphoric acid and 66 pounds of actual nitrogen. After a crop of 300 bushels per acre, there remains in the soil 120 pounds of potash, 93 pounds of phosphoric acid

and 8 pounds of nitrogen. Nitrogen is the most elusive element in fertilizer, and it is not economical to apply much more of it in any one season than the crop grown that season consumes. The margin between what a crop of this size consumes in nitrogen and the amount applied in a ton of this fertilizer is so narrow that if the crop depended altogether for nitrogen on what was applied in this way its growth would suffer. This is most obvious in dry seasons. If potatoes are planted as they should be, on land containing more or less organic matter, nitrification is in process and supplying enough available nitrogen for all the crop requires to do its best.

The office of nitrogen is to promote vine growth of the plants, and an abundance of this element causes a heavy dark green growth, and a fertilizer not well balanced with phosphoric acid and potash might, and invariably does, produce much vine growth with few and small tubers. If any element is lacking, toward the last of the season, it should be nitrogen, whereas plenty of available nitrogen applied early in the season promotes vine growth to cover the ground, prevents evaporation of moisture, checks weed growth, and a good crop usually results. Potash and phosphoric acid promote formation and develop tubers later in the season, which grow until the vines die.

After much discussion as to the relative merits of muriate or sulphate of potash for this crop, many growers accept the belief that the sulphate produces a better quality of tuber. Manufacturers charge more for goods with the potash-content wholly in the form of sulphate. Fertilizer composed of quick-acting forms of nitrogen usually yields best results. The method

and time of applying fertilizer is important, and is more fully dealt with under "Planting and Cultivating the Crop."

CULTIVATING THE CROP.—There should be at least two deep cultivations. A two-horse double cultivator will do deeper and better work and more of it at the same time and get nearer the rows without disturbing the seed than a single horse cultivator; however, good work can be done with the latter. The cultivator should be started as soon as the field is planted, running it as deep and as near the rows as is safe to do without disturbing the seed. The planter wheels having packed the soil between rows, cultivation loosens it, allowing heat and air to penetrate. When this is finished the weeder, brush harrow or plank drag should be used to level remaining ridges, because if extra soil remains over the rows it prevents air and heat from reaching the seed, is valueless, and retards sprout growth, and, if rains follow, may injure them and cause weak, spindling growth. Allow no more soil over the seed than necessary, until the plants are well out of the ground, seed being three to four inches deep after ground is leveled. Go over the field every few days with the weeder, until sprouts approach the surface, then discontinue until vines are so well established that the weeder breaks off few, if any. A fixed rule is never to run cultivator, weeder or other implement so as to break or cut off any portion of the root system, or break off a sprout where a plant is wanted. If the seed piece substitutes a sprout for a broken one, it is weaker and later in maturing, and with early potatoes is a loss.

When sprouts are well up and rows plainly visible, give a second deep cultivation, running the cultivator

well up near the rows, being careful not to cut off any portion of the root system. This will kill weeds between the rows, but many remain along the rows not accessible to the cultivator. Plants are now ready for the second application of fertilizer. If the nitrogen be now in the form of nitrate of soda, plants having root systems are in condition to absorb it, and very rapid growth will be forced. In this second application use the planter, removing both plows but retaining the fertilizer attachment and disc coverers. Drive right over the rows, drilling the fertilizer while the disc coverers bury fertilizer, weeds and potatoes. If plants are stalky and strong they will push through this loose soil with which buried, and the process will kill all small weeds. Set the disc coverers wide enough apart to make a broad, low hill or ridge, throwing some three inches of soil around and over the plants and fertilizer drilled along the row. The vines will at once put forth one or two new sets of roots above this, and in about two days the fertilized earth will be filled with new, white feeding roots.

This burying process is a Maine practice. While not advocating extreme ridge or hill methods, large crops of good tubers are rarely obtained unless moderately hilled. The latter is advocated because preventing root pruning. Two applications of fertilizer are best, since it is a waste of nitrogen to apply a portion broadcast before planting, if any of it is in the form of nitrate of soda. No method economizes time and labor as this does. Both the fertilizer and burying is done in once driving over the field, costing less than one and one-half hours' time per acre for both. Burying potatoes, especially early varieties, should

Applying the Second Application of Fertilizer and Burying the Potatoes, Weeds and Fertilizer

be done as soon as rows show plainly. On later and more vigorous varieties it can be done without injury when from four to six inches high. This method kills all weeds and grass and causes the formation of new root growth. On early kinds, burying deeply, when too large, hurts the growth; hence with these it is advisable to so adjust the machine that they will not be entirely buried unless the weeds have a bad start, when everything should be covered out of sight and deep enough to kill all weeds. The cost of hand labor to remove weed growth will exceed the damage done the vines by burying; much depends upon whether sprouts have come up strong and stalky; if weak and spindling they will not stand deep covering without injury. Vigorous, stalky plants will, in about two days, shove right up through several inches of loose soil.

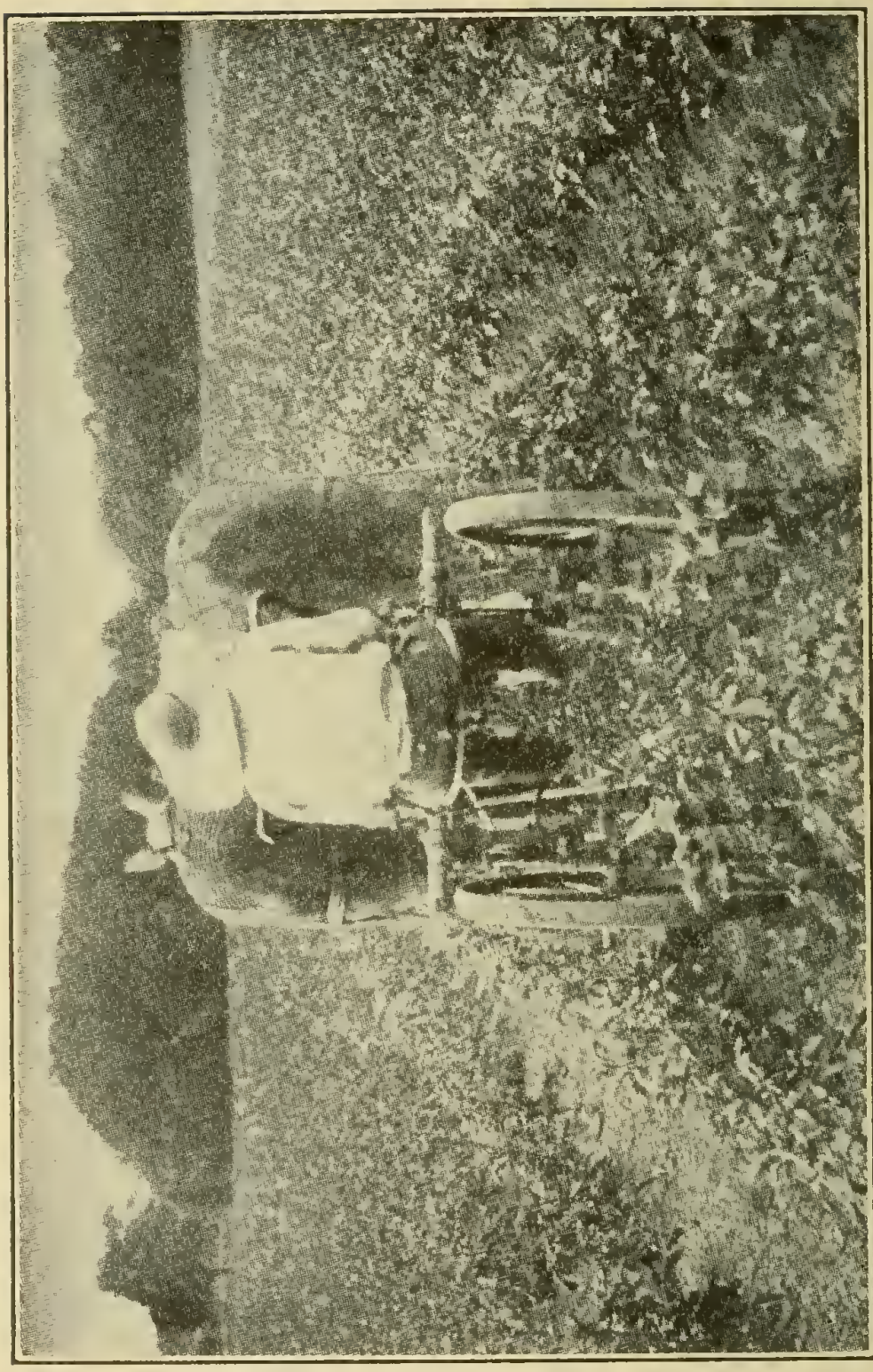
If some fertilizer falls on the leaves, no harm will be done; the plants shove up, making new growth from the centre, and all leaf growth covered remains buried and perform, no further leaf functions to the plant. There are two advantages in this—any eggs of the beetle laid on small plants prior to burying are destroyed. In some cases these will prove the greater number laid during the season. Another is, that the plants will send out a new set of roots from each joint of stalk below the surface of the soil thrown around them, thus enlarging the root system. Applying fertilizer at this time, and placing it where the plants can at once feed upon it, more than offsets the temporary check any good vigorous stalk sustains when small, by being covered with loose soil, even to the depth of several inches. The cultivator should be run between rows immediately after burying the

plants, to loosen the soil between rows and prevent evaporation of moisture. If small weeds spring up along the rows again, a second hilling is sometimes advisable. Only enough soil should be thrown up and around the plants at this time, however, to smother the weeds and form a dust mulch; usually it is not advisable to make this second covering; the grower must be governed by weather conditions and weed growth in this; it is always a matter of individual judgment.

The last working of the field should be with the cultivator narrowed up to avoid tearing down ridges, and it must be run very shallow, just enough to form the dust mulch between rows. This system is not applicable to sections where dry weather prevails. Each grower must decide for himself and be governed by his soil and climate. Potatoes grown in the ridge system are more easily dug than with level culture, and in a wet season are less apt to rot. They are, too, less sunburned, and a moderate ridge system of cultivation seems to possess more advantages than either level or extreme ridge method.

INSECTICIDES.—Paris Green, Arsenate of Lead and Bug Death are those most used, and each has its objections and limitations, and the grower must decide which to use.

PARIS GREEN.—This is most generally used for killing eating insects. It is a copper compound of arsenic, and a deadly poison, and should never be kept where children or live stock can reach it. Its action on foliage is harmful, and when applied in too strong solution is fatal to the plants. When too weak a solution is used fields turn a light green, lose their



CULTIVATING THE CROP

thrifty appearance and become a prey to blights. Many believe it to be the cause of the late blight or rot; this is true only in the sense that its use so weakens the plant that the power to resist disease is lowered. Its depressing effect on the vines is greater if the leaves have been more or less eaten by insects. This is especially true of the work of the flea beetle, which it does not kill to any appreciable extent.

Some authorities assert that arsenical poisoning is due to the free or water soluble arsenic which the green contains, and that the addition of lime will prevent all injury. To some extent this is true, and more or less lime should always be used in any mixture containing Paris Green for spraying purposes. That this injury can be wholly overcome by the addition of lime, has not been the experience of one of the greatest potato experts known. That its use on potato fields will, in time, impregnate the soil to the extent that it will impair the growth of vegetation seems plausible, in view of the recent developments in Colorado orchards. It must be remembered, however, that the amount used per acre of orchard was several times the amount usually used on potatoes, and with them, where a rotation is followed bringing them on the same field only once in three or four years, it would take a much longer period of time for the soil to reach conditions now found in some of the poisoned orchards of the West.

For killing the Colorado beetle there is nothing cheaper than Paris Green, and the grower using it in a spray mixture should add a pound or two of lime to every pound of Paris Green. If Bordeaux is used, the lime in the Bordeaux will be sufficient, the Paris Green being added to the Bordeaux at the rate of one pound

to each acre of potatoes to be sprayed. Paris Green has no fungicide value, and its addition to the mixture is simply to combine an insecticide with the Bordeaux. Used in this way, it will adhere to vines better than if used alone. Those who use it in dry form will injure the potato vines least by mixing it with land plaster (gypsum), at the rate of one pound of Paris Green to fifty of plaster, dusting over the plants with any dusting apparatus.

ARSENATE OF LEAD.—This was the result of the demand for some poison as effective as Paris Green, but without its injurious effects on foliage. It has two advantages over Paris Green, in that it adheres better to leaves during rainy weather and that the injury done vines is less apparent. Experiments prove the loss in yield of tubers by its use not to exceed one-half that caused by Paris Green. One objection to it is, its slow action in killing the bugs. Fields, after the third spraying with it, have been seen literally swarming with larvæ of the beetle.

It is more costly than Paris Green and is equally dangerous to live stock, and, since more pounds of it are used per acre, it is open to the same objections as a soil poisoner as is Paris Green. However, if obliged to resort to the arsenical poisons as a means of killing eating insects, use Arsenate of Lead in preference to Paris Green, making several sprayings within a few days' time when the slugs are hatching out. In this way, insects can be destroyed with minimum injury to the plants from arsenical poisoning. As it must be applied as a spray, it is not so available for those not equipped with spraying apparatus as is Paris Green, or Bug Death, either of which can be applied in dry form.

BUG DEATH.—This differs from either Paris Green or Arsenate of Lead. It is not an arsenical poison, but when used in liberal quantities is as effective as either of the others. Its advantage over them is that it will not injure the foliage, no matter how freely applied, and does away with all injury from arsenical poisoning to any plant, as well as the more serious one of poisoning the soil. It can be dusted over the plants as a dry powder or applied in the sprayer with water alone or Boadeaux Mixture. Used dry, it is valuable for killing the old beetle when plants are very small. As vines are more tender at this stage of growth, the use of Paris Green is to be avoided where possible, even when used with Land Plaster. The objection to Bug Death is that it is more costly than Paris Green, but experience proves that its beneficial effects more than offset the extra cost.

Growers not having spraying apparatus must either leave their crop unprotected from blight or use something easily and economically dusted. These find Bug Death most valuable. A small bag made of cheese cloth or coarse burlap, at a few cents' cost, answers for dusting the vines. If thoroughly applied three or four times during the season, when vines are damp with dew, it not only keeps off all insects, including flea beetle, but gives as good protection against blight as Bordeaux Mixture, without involving outlay for spraying outfit. This method of dusting is not practicable on large acreage, taking too much time for the work, which must be done thoroughly. The dust-blowers on the Market do not blow enough to be effective, either as an insecticide or protection from blight, but the small grower can in no way so easily obtain desired results.

As an addition to Bordeaux Mixture, it is especially valuable at dry times. With from fifteen to twenty pounds added to the amount of Bordeaux Mixture to be applied to the acre, it makes a thick, heavy mixture, which, coating the leaves thoroughly, prevents a large amount of evaporation of moisture from them, and enables plants to live and thrive through a drought, when otherwise they would die if sprayed with Bordeaux Mixture and Paris Green. If used dry, not less than 25 pounds per acre should be used at an application.

BORDEAUX MIXTURE.—The standard spraying mixture used on potatoes as a preventive of blight and a repellant of the flea beetle, is Bordeaux Mixture. It is condemned by so many growers that there is little doubt that it is not all the early advocates claimed for it. Experience inclines to the belief, that the vitality of the seed planted, many times determines, whether or not the crop can be saved by spraying with it. It is questionable whether the action of the mixture itself is not weakening the vitality of our potatoes, despite the protection it usually affords against blight. Fields kept thoroughly sprayed during July and August, and examined in September, rarely fail to reveal leaf injury caused by Bordeaux. This appears in a burning, browning and hardening of the leaves, and in some cases is a pronounced injury. The later in the season vines remain green, the more this burning of the copper sulphate shows, yet, when well made and intelligently applied, it will increase the crop of tubers in most any kind of a season, especially in the more northern states.

The method of preparing Bordeaux has much to do with its efficiency in protecting the vines, and there

are doubtless many using it who fail to mix it properly to obtain best results. The old formula is seldom used now. This did not carry enough lime, and injury led to use of more lime and less vitriol. The 5-5-50 formula is used, but 5 pounds blue vitriol and 6 pounds of lime to 50 gallons of water is better. The ready Bordeaux Mixture or the ready mixed dry Bordeaux has apparently not given as good results as the home-made. The new process lime manufactured answers for making Bordeaux, but more of it than of common lump lime should be used. Use 7 to 8 pounds new process lime to 5 pounds of blue vitriol to get the same effect as 6 pounds of common lump lime well and properly slaked. New process costs more than lump lime and more is needed to obtain the same results. Its use is therefore more expensive. To the small, and often to the large grower, the facility with which it mixes, saves time enough to more than compensate for the added cost. Every grower who plans to spray his crop should always have a supply of new process lime on hand.

Many plans of making and mixing Bordeaux have been suggested, indicating how diluted lime water is contained in one barrel, the diluted blue vitriol water in another, and both run into the spray tank through pipes or hose, where they mix together as they enter. This is satisfactory where water is handy and can be pumped to the height which permits this to be done. This is seldom the case in actual field work with the average grower. Probably 90 per cent. of the water used to make the mixture is drawn a distance to the field. If the distance be more than a few rods, the quickest and most economical way is to haul the water

in large barrels by wagon, rather than in the sprayer itself. In this case it is much better to slake the lime and dissolve the blue vitriol in that section of the field where the greatest saving of time can be made, when spraying. Stock mixture should always be made even for a few acres, and, as both the lime and vitriol will keep indefinitely until mixed together, much time can be saved by preparing stock in advance.

The following stock solution will make 500 gallons of Bordeaux: Procure two large barrels holding 50 gallons each, dissolving in one 50 pounds of blue vitriol as follows: Obtain a box about 12 inches square and 10 to 12 inches deep, and, after removing the bottom, tack on the bottom of this frame a piece of brass or copper wire netting. Nail two cleats along opposite sides near the top so the box will set in the barrel resting on the cleats. This places the box in the barrel some 8 or 10 inches, according to depth. Pour the 50 pounds of blue vitriol, to be dissolved, into the box, and fill the barrel with water by pouring it through the vitriol. More than one-half of the vitriol will dissolve in filling the barrel, and as the bottom of the box is in the water the balance of the vitriol left in it is the best possible position to dissolve quickly, and in an hour or two all will be found ready for use. By making the box with copper nails and tacking the netting on the bottom with copper tacks, the box will last for years and will save hours of time as well as vitriol. This provides 50 pounds of vitriol dissolved in 50 gallons of water, or one pound of vitriol to each gallon of water. In the other barrel slake 60 pounds of good lump lime. First, pour two or three pails of water in the barrel, then add the 60 pounds of lime. A good stirring paddle

should be at hand, for the lime will soon begin to boil. The mixer must protect his eyes. Add more water as needed, always enough to slake the lime without burning. In 10 or 15 minutes the lime will be slaked to the consistency of thick paste. If this be done the night before wanted, better wait until morning before filling the barrel with water, as the lime will slake better if kept hot for a few hours. When needed, fill the barrel with water. This provides 60 pounds of lime in 50 gallons of water.

When ready to spray, first fill the sprayer half full of clear water, then add five gallons of the blue vitriol water. If an insecticide is to be used, add it at the same time. Next, take 5 gallons of the lime water, give the pump a turn or two to start the agitator and stir the mixture, and if the sprayer is not full, fill it by adding clear water. This will make as good Bordeaux Mixture as can be obtained, and at lowest cost.

As the lime water is consumed, add more water, always using all the lime the barrel contains in consuming the 50 gallons of blue vitriol water. The object in adding more water to the lime, is to so dilute it that it will readily pass through the strainer in the sprayer tank. This also dispenses with straining out the coarse material which settles in the bottom of the lime barrel. Thoroughly sprayed with mixture made in this manner five or six times during the season by going over and back on the rows at each spraying, potatoes will seldom be badly hurt by blight or rot. When this does occur, the chances are that there are other and obscure causes back of it, such as poor, weak seed, which should never be planted.

SPRAYERS.—These should be well built, with large pump capacity, and a strong agitator working close

to the bottom of the barrel or tank, keeping the mixture in perfect suspension. Most machines are now made to spray four rows at once, and on rough, uneven land, this is as many as advisable to try to cover at one time. On large, smooth fields, free from stones of any great size, six rows can be covered at a time, provided the pump has capacity enough to preserve the working pressure. A working pressure of 75 to 90 pounds is needed when the machine is working with the spray turned on, whether spraying four or six rows at a time.

A sprayer that will not maintain this pressure, day after day, is out of order or lacks pump capacity. The pump should be made entirely of brass and copper, and the plunger so made that the wear of both plunger and cylinder can be taken up by putting on the plunger leather or canvas cups. These will make the pumping capacity of the machine as good as new. Two or three days of continuous work will so wear these cups that the pressure will begin to fall, and often before the operator realizes it, he will be doing inferior work, and another set of cups will be necessary. A sprayer requires attention and must be kept in first-class working condition, otherwise inferior work results, and the grower, failing to obtain results, ignorantly condemns the process. Either the operator fails to understand working the machine and its upkeep in perfect order, or the machine itself is defective if results prove unsatisfactory. Bordeaux Mixture is hard on any sprayer because of the lime in its composition, and in the haste of busy times, many fail to properly strain the mixture as it enters the sprayer, resulting in clogged nozzles, impatience of the operator, and unsprayed parts of the field allowing insects and blight to get a start.

The Vermorel nozzle seems best for the potato spraying.

The pump must be fitted with two leads of pipe, a return pipe to the tank and one leading to the nozzles, and both fitted with a stop cock. After filling the tank, when starting for the field, start the pump and open the stop cock leading to the tank. This allows the agitator to thoroughly stir the mixture while the pump is pumping it back to the tank. When the field is reached, shut off the stop cock leading to the tank, allow the pump a few strokes to create as much pressure as wanted, and then turn on the stop cock leading to the nozzles. An allowance of a few feet should be made before entering the rows so that all nozzles may be working in good order when the first hills are reached. A little practice in turning the spray on or off will enable the operator to spray the end hills, when entering and leaving the rows, as well as the others.

A first-class power sprayer will be fitted with a waste gauge leading to the tank and so arranged that by turning a thumb nut the amount of pressure can be easily changed. This waste gauge should be set at all times so that it will relieve the pressure on the pump before breakage occurs on any other part of the machine. It should also be fitted with a pressure gauge, allowing the operator to see at all times the pressure the pump is under. Every machine should be fitted with a good strainer with brass or copper wire screen of 30 meshes to the inch. This prevents anything passing to the spray tank that will clog the nozzles. Some sprayers are fitted with a strainer screen of too small a surface, which easily clogs when filling the tank, especially when straining lime. The aperture in the spray tank should

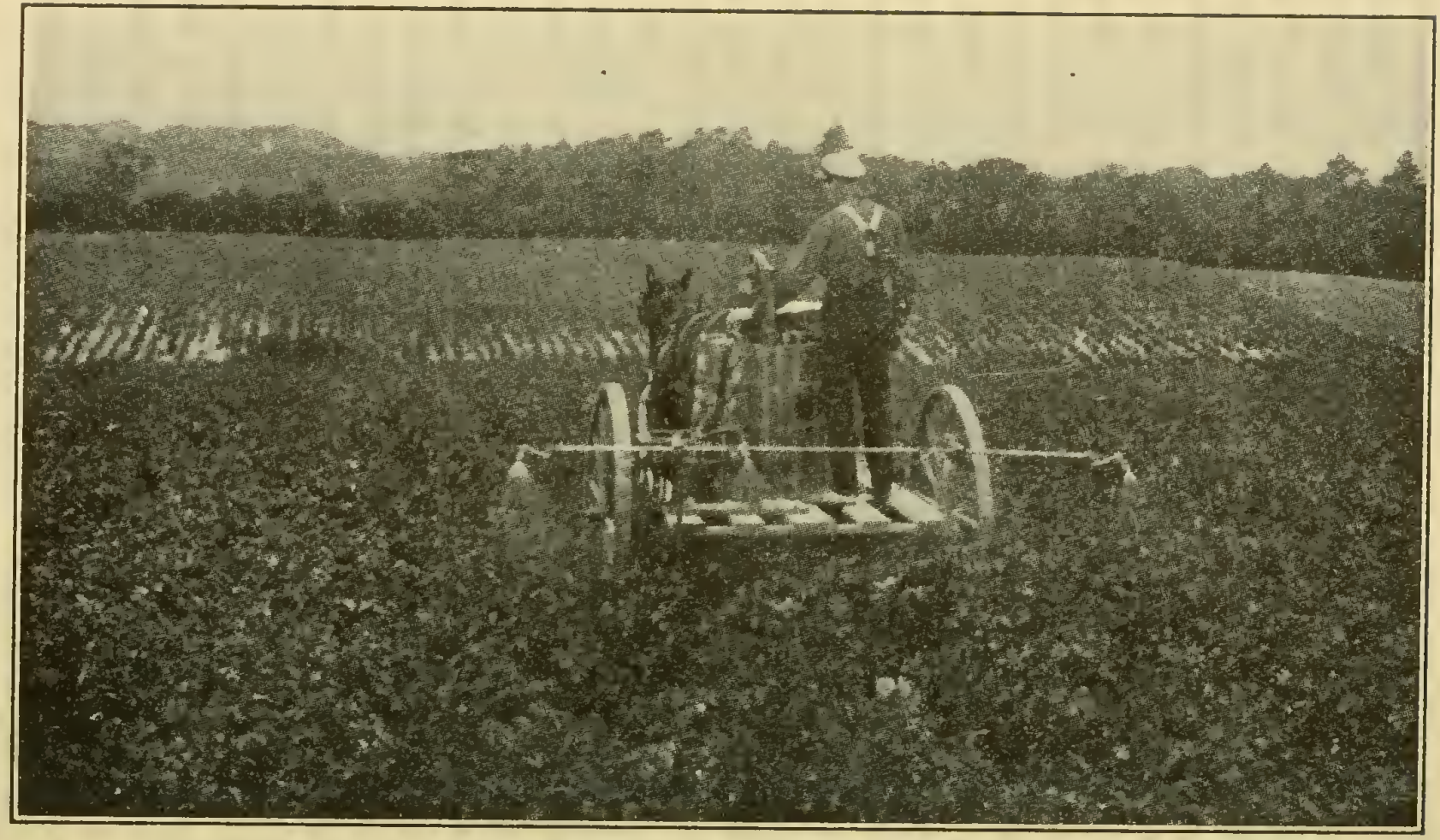
be large enough to admit a strainer of 25 to 30 square inches of screen. This allows surface enough to rapidly fill the tank if reasonable care be exercised. All these things are of importance to the grower. Often a small screen surface strainer requires more time to fill the tank than to apply the mixture to the field. Any waste of time, when every moment counts, results in slighting the work, and must be guarded against. A good four-rowed horse power sprayer kept in proper condition will perform as perfect work on large areas as the small grower does with a knapsack sprayer.

SPRAYING.—The importance of spraying as a preventive of blight is underestimated. This is most noticeable in late blight or rot. There is hardly a season without late blight, and the extra yield from sprayed fields more than pays all cost of spraying. Spraying thus becomes crop insurance, which no careful grower can afford to ignore.

To be effective, spraying must be carefully and thoroughly done. In ill-planted fields, with crooked rows or rows of varying distance apart, perfect work cannot be done. The spray should be forced all through the vines, coating the under as well as the upper side of the leaves and stalks. Spraying is a preventive, not a curative necessity. Hence, it should begin before blight is established, and this is true of the beetle larvæ as well. To spray effectively, demands much of the sprayer. Nozzles should not be set to point straight down, but a little forward or backward. The larvæ of the beetle seeks the crown of plants and vines, and feeds on the tender new leaves there. The spray must be forced into the crown of the plant and at the same time, angle enough given, to force it among the

stalks and under the leaves, coating both with the mixture. There should be pressure enough to force the spray from the nozzle like a jet of steam. The nozzles should be as near the rows as possible and spread enough given the spray to cover the whole of the row. Avoid the mistake of not adjusting the nozzles to the size of the plants to be sprayed, otherwise only a narrow strip through the center of the row is covered. If nozzles are placed too high, the spray loses its force, and consequently fails to reach the stalks. Neglect this precaution, and the stems, stalks and under side of the leaves derive little benefit, although the work has apparently been perfectly done.

There can be no thorough spraying in going one way over the field. The best results are obtained with the minimum amount of mixture and use of single nozzles. Going over the field and allowing the first application to dry on, and then reversing, reaches both sides of the hills, and the small crown leaves where the tiny slugs congregate, and these then get two sprayings at different angles, which practically covers and kills them. Spraying should begin when the vines are from six to eight inches high. Fine caps should be used on the nozzles at this first application, as it saves material, and a sprayer holding sixty gallons can then be made to cover an acre going both ways. If insects are plenty, the second application should follow the first in a few days. It is sometimes better to make the first three sprayings within ten days if the weather is very warm and slugs are hatching rapidly. These must be killed before any damage is done the vines. At this period of rapid growth the foliage is increasing so fast that plenty of unsprayed surface is found in



Spraying, when the vines cover the ground, with a high-pressure 4-rowed sprayer
field averaged 300 bushels per acre

the crown of the plants by the little slugs as they hatch out. For this reason three sprayings are sometimes needed to entirely rid a field from slugs. If this work is done as it should be, there will be but few bugs left to bring out a crop of slugs later in the season, and in the subsequent sprayings an insecticide may not be needed.

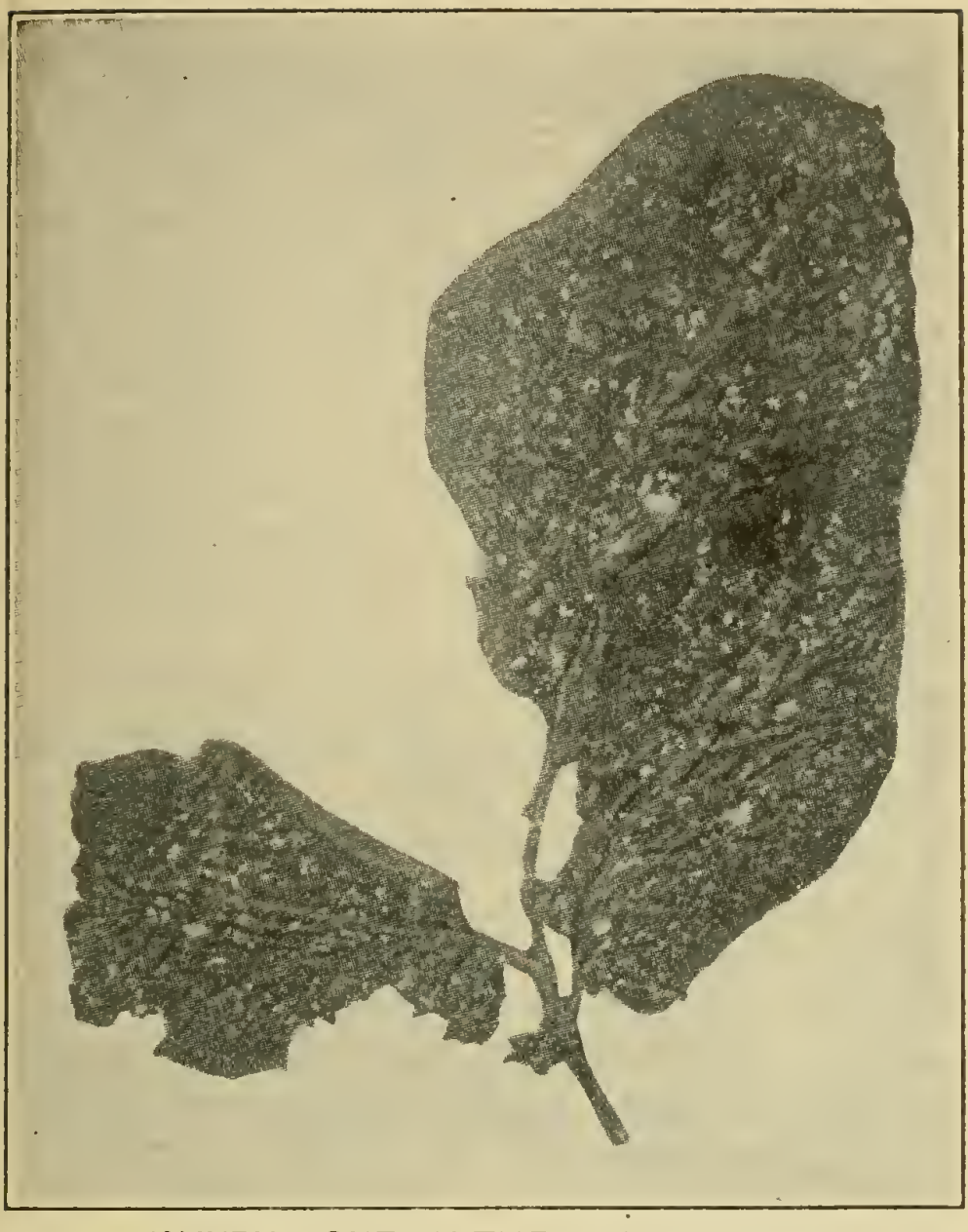
A field badly eaten by either the flea or Colorado beetle is more likely to be attacked by either the early or late blight than one kept free from them. This is also true of arsenical poisoning, which is much more likely to injure the plants if badly eaten by insects, especially the flea beetle. The free arsenic, acting on the raw, freshly-eaten leaf edges, seems much more harmful to them than to uneaten foliage. After the first three sprayings, the others can follow at intervals of ten days to three weeks, according to weather conditions. Dry, cool weather is unfavorable to blight, and the period between sprayings can then be longer, while moist, hot weather, being favorable to the spread of late blight or rot, necessitates shortening the time between sprayings. There is a time in the period of potato growth when it seems most susceptible to disease, especially the late blight; this is just when passing out of the blossom stage. If it escapes this critical period without harm, it is comparatively easy to keep the vines green until late in the season in the more northern sections and until killed by frost. This means a greatly increased crop, as the last few weeks the vines remain green, is when the potato makes the most profit for the grower.

For this reason it is advisable, when potatoes are passing out of the blossoming stage, to use more

gallons of Bordeaux Mixture per acre than at any other time. On vines that thoroughly cover the ground not less than 125 gallons per acre should be used at this time and frequently more. Spraying should never be stopped because the vines cover the ground and will be broken and more or less trampled upon when driving through them. Vines that have reached this stage will not be cut off by the wheels of the sprayer going over them. Rolling them down with the wheels, while it looks badly, will hardly bruise them except on side hills, where the sprayer slides more or less. When this happens a few will be cut off, but the damage is small compared with the good done in preventing blight and promoting growth of tubers. No one should hesitate to spray, even if the vines are so rank and tall that the rows can hardly be defined. A growth of vine of that magnitude certainly needs the protection of thorough spraying.

INSECTS

THE FLEA BEETLE.—Probably no insect does greater damage in many sections than this. They come in countless numbers and feed upon the leaves, eating small round holes through them until at least half of the leaf surface is eaten. Potato vines so eaten are much more susceptible to arsenical poisoning and early and late blight and other fungus diseases. Poisons do not seem to have much effect on this little black pest, and about all that can be done is an application to disperse them. Bordeaux Mixture, thoroughly applied, has this tendency. These insects usually come in great numbers when plants are very small. Frequently vast damage is done before the grower is



INJURY DONE BY THE FLEA BEETLE

aware of their presence or before there is vine enough to suggest spraying. In Maine a late August brood often does serious damage to unprotected fields, even when vines completely cover the ground. Growers not provided with suitable spraying apparatus, and having small areas to protect, will find that Bug Death dusted over the vines, when damp, will prove great protection against this pest.

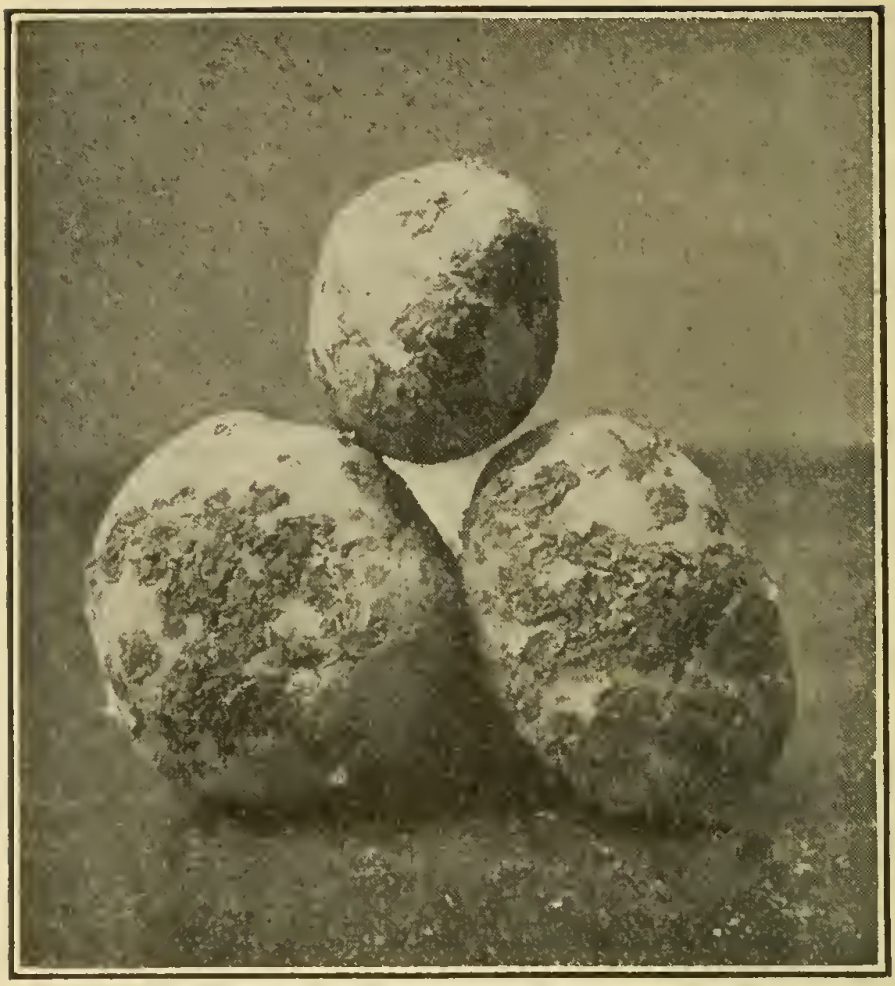
The flea beetle is difficult to fight, and because of its size and peculiar habits may do great injury before the grower is aware of the extent. Not only do they eat the leaves full of little holes, but in many places eat part way through, thus making small depressions. Paris Green settles in these, causing the target-like markings of arsenical poison injury, making it more pronounced on fields that are badly infested. The ravages of this pest have a decided effect also in causing early blight; so much so that it seems certain that early blight would seldom, if ever, cause much loss, unless plants suffered loss of vigor through this pest and arsenical poisoning.

THE COLORADO BEETLE.—This is probably the best known of all the potato-eating insects. It seems to have been a native of Colorado, hence its name. When settlers carried the potato into its home it at once formed a liking for this plant, and at once spread east in search of its new-found food. It reached Iowa in 1861, Wisconsin in 1862, Illinois in 1864, Michigan and Indiana in 1867, Ohio in 1868 and Pennsylvania in 1870. Twelve years later it reached Nova Scotia, and has been a pest over the whole East ever since. That it will ever disappear seems improbable, although it greatly varies in number in different sections at various times. It flies in bright, hot weather, but the distance it can go in this way is not known. Observation leads to the belief that it never flies in damp, cool weather, and the approach of evening or a sudden shower precipitates it to the ground, regardless of where it is. It is frequently found washed up on the shores of lakes and ponds, sometimes in countless numbers, a sudden cooling of the atmosphere causing it to fall into the water in its flight across.

It winters buried in the soil, coming out the first hot days of spring and sometimes appears in such numbers where plants are just breaking ground that all growth made for several days or even weeks is consumed. At this stage of plant growth it is hardest to combat, as there is so little leaf surface that it is impossible to poison them. They mate at once and egg-laying begins within a few days if the weather remains warm, the little plants frequently having several hundred eggs on them when two or three inches high. If the plants are covered with soil, it will destroy these first egg clusters, and with very late plantings will often prove all that is needed to rid a field of the pest. Fighting them should never be delayed until damage is done the plants, as it will result in a loss of crop, amounting to many times the cost of labor and material needed to rid the field of them. The remedy is described herein under "Insecticides."

SCAB.—This is a fungus disease, causing rough-pitted patches, or, in badly infected soils, covering the whole surface of the tubers, often making the whole crop unmarketable. Some varieties are more susceptible to scab than others. The "American Giant" is scab-resisting, but its cooking quality is poor, and hence it commands a lower price. As a rule, the better the quality of the variety, the more susceptible it seems to scab.

The disease is widespread, due to planting infected tubers; hence, the remedy largely lies in planting seed free from it. A system of crop rotation, resulting in the use of the same soil for growing potatoes, only once in three or four years, generally averts the disease. It does not thrive in acid soil, even though present in



POTATOES AFFECTED WITH SCAB

it, or even when scabby seed is planted, and consequently the crop is sufficiently free from it to be readily marketable. Soil may be sweetened by lime to the point where clover thrives, without being sweet enough to forbid potato growing because of scab. Plant seed free of the disease and thus avert danger from it.

If seed showing spots or patches must be used, disinfect it. One method of doing so, is to soak the tubers, before cutting, in a solution of formaldehyde. This is called formalin solution. It is not a costly process, if sensibly handled. There are several methods; but the following will answer where up to 100 or 150 bushels of seed is used:

Use five barrels of fifty or more gallon capacity each, set them in a row out of doors, put into each 35 gallons of water and add one pint of formalin of the standard 40 per cent. solution to each barrel. Put seed into coarse bags (bran sacks are best), tieing near the top. This allows contents to spread in the bag and thus each barrel will hold three bags of one bushel each and the 35 gallons of solution will cover the lot. The five barrels soak 15 bushels at a time, or about all one man can attend to at once. Soak from one and one-half to two hours. While this is in progress more seed can be sacked and made ready for treatment, when the first lot is removed. One man can thus prepare and soak about 100 bushels per day. The cost of formalin should not exceed $1.25 for five barrels, and each barrel should soak at least 40 bushels of seed. When seed is removed from solution, turn out on the ground, one bushel in a place, and throw a bucket of clear water over each lot, to rinse the solution off, as it makes them nicer to handle when cutting. When dried, they can be stored until needed for planting.

All articles used in handling the seed should be dipped in the formalin solution before being used for the soaked seed, so that any of the scab fungus which might adhere to them will be killed, and if the seed is restored to the bin or other place, a bucket of the solution and an old broom should be used to thoroughly disinfect the storage place in advance. It is a serious matter when soil becomes badly infected with scab, and the quickest way to eradicate the disease is to abandon the use of that soil for potato growing for several years; meantime growing green crops upon it and plowing them under, which will start a slight

acidity and aid in curing the disease. Lime, ashes or heavy applications of manure tend to sweeten the soil and promote growth of scab disease.

Sulphur is sometimes used to dust over the seed when cut and also scattered along the row when planting. At times this proves a perfect remedy, while again it amounts to little. The condition of the soil itself doubtless has much to do with this. It is claimed that spreading seed potatoes to sprout, where the direct rays of the sun strike them, kills the scab fungus. When scab fungus is present in the soil, treatment given the seed does not insure a clean crop, but does prevent planting the disease with the seed. The disease is often present in a limited way in soil favorable to its growth and yet does not affect the tubers enough to injure the market value of one season's crop, unless the scab in vigorous condition has been planted on the seed. Land, reasonably free from it, will usually grow good market crops of tubers if a rotation follows which will not repeat potatoes on the same ground oftener than once in three or four years. This is more certain if manure is not used on the ground; but rather that the humus-content may be maintained by plowing under green crops or clover sod, and using chemicals or commercial fertilizer to supply the plant food needed by the potato crop.

LATE BLIGHT OR ROT.—This probably causes more loss to northern growers than any other disease attacking the plant. It presumably lives through the winter only on the tuber itself and can frequently be readily detected when cutting seed, although it might be present in many tubers cut and escape detection by even an expert. It may affect but a small part of the tuber

and, in cutting, the part affected may not be cut through, and hence not revealed even to an expert. When cutting seed, if the cut surface shows black-like threads running through the tuber, it must be discarded, as this is probably the late blight or rot in the dormant state in which it passes the winter. It may also be detected by sunken spots on the tuber's surface. These are usually irregular in shape and vary in size from mere spots to extending over nearly the whole surface of the tuber. These spots usually develop while in winter storage, and in some cases quite a percentage of the lot show the spots in spring, although at harvest time no trace of them was visible.

When soil and weather conditions are favorable to the growth of this fungus or infected seed planted, it spreads to the surface by the roots and stalks. The whole root system and stalks below the surface of the ground are frequently found badly infected when the thoroughly sprayed top shows no blight whatever, but a slight pull will break the stalk off just below the soil's surface. This is one reason why early spraying for late blight or rot is necessary, as it may be working towards the surface on the roots and underground stems when infected seed has been planted, and even the most critical observer cannot detect it unless an infected hill is dug out. The sprout or stalk springing from any seed piece badly infected when planted is likely to come up weak and spindling. On the other hand, many seed pieces may be so slightly infected that the vigor of the sprout is apparently little impaired and the field make a splendid growth.

If at about the time plants are going out of blossom, and sometimes before, the weather becomes hot, with

frequent rains, the spores of the blight reach the surface, and if the vines are unprotected the spores spread very rapidly over the leaves and in a few days will turn a fine looking field into a mass of blackened, dying vines, with very offensive odor. Rotting of tubers does not always follow blighting of vines, although usually the case. If no rain falls from the time vines become infected with the spores until entirely dead, and the unripe tubers in the ground become ripened off or hardened up, there is little danger from it. Tubers thoroughly ripened seldom rot in the soil unless it becomes very wet. Again, a field that indicates little blight on the vines, perhaps none to the average grower, and keeps green until frost, may have its tubers rot badly. This results from the spores of the blight being washed from the leaves down upon the unripe tubers, which they immediately attack.

Vines may be so slightly affected by blight spores that the casual observer would not detect it, and enough spores remain to be washed down in the event of heavy rain upon the unripened tubers and cause severe rot. A field can also become infected with blight by the spores being brought to it by the wind from a field miles away. In this event it is usually detected on the leaves near the top of the plant. A leaf showing a portion turned black and drooping with a white mold on the under side, can safely be diagnosed as affected with late blight. If good, vigorous seed has been planted and the vines kept thoroughly sprayed with Bordeaux Mixture, beginning when they are only six or eight inches high, little danger exists of losing the crop from late blight or rot. If blight gets well started, little hope exists for the crop.

GREEN MOUNTAIN JR. POTATO FIELD

Digging by hand, yield 354 8-60 bushels per acre of fine smooth tubers. No dressing or commercial fertilizer used. Bug Death applied three times during the season, dry

HARVESTING AND STORING.—Potatoes will keep better over winter if digging be delayed until cool weather. Where crops ripen in early August and second growth threatens, this cannot be done. After a tuber fully ripens so that no change occurs in size, rain causes the soil to adhere to it more or less, even though the soil dries again. Tubers remaining in the ground weeks after growth ceases are seldom as bright and clean as those dug earlier. Potatoes ripening in early August are difficult to keep in fit condition to plant the following spring. Sprouting is likely to occur in early winter with loss of the tubers' vigor. Overcome this by using specially constructed underground cellars for storage, where low temperature without freezing is maintained.

Large growers who store crops should possess such a cellar. Even if growers sell direct from the field, it is desirable at times to harvest faster than possible to market to advantage. A cool, dark place, easy of access from the field and to remove from later, will save its cost in a few years. There are two types of storage, one with frost-proof walls where potatoes are kept above ground in the body of the building in which provision has been made for heat from basement stove or furnace circulating between outer and inner walls. This is the best if building be accessible by railroad siding. Here potatoes can be bought, sold and kept in quantity, a caretaker being employed in winter.

A building with basement cellar for use of the average grower is better. Such a building, with room above for farm implements, is worth its cost for this purpose alone. This is usually built against a side hill or knoll, the floor over cellar being at ground level at upper side

DIGGING SNOW POTATOES—Yield 300 to 400 Bushels per Acre

or end of the building, making this floor easy of access by team. The ground on the lower end or side, being level with the cellar bottom, permits contents to be removed with little labor. The crop as drawn from the field is dropped through hatchways from the floor above into bins below. Care must be taken to avert bruising the tubers in storing. This can be done by means of a tube or chute made of burlap and extending from the vehicle on or hatchway in the upper floor to the cellar. The burlap tube can be drawn up and handled so as to permit spreading the tubers out in the bin without bruising. This permits rapid storing when harvesting, with a minimum amount of work.

The more of the cellar under ground and well ventilated, the cooler will it be in warm weather and the longer will the contents keep without sprouting. Constructed in this way, no artificial heat is required, even in coldest weather. If flat stone can be had cheaply, they make a good wall foundation; this can be carried up several feet, but the remainder should be grout or concrete. This is apparently the best wall for a potato cellar. An outside coating of Portland cement before banking with earth should make such a wall sufficiently water-tight. The top of the wall should be 12 to 14 inches thick and sills laid even with the outside edge and pointed with cement mortar. The sills on the wall need not be heavier than 4 by 4 inches, leaving 8 or 10 inches inside the sill. After floor timbers are in place, space remains to brick up and by setting brick on edge, two dead air spaces remain, carry this right up around the floor timbers, which should rest on the sill tops, thus getting their full strength. The cross sills should be heavier timber, so arranged

that the supports for them will come just right for the division of the cellar into bins. The floor above should be either double thickness of boards or boards with two-inch plank above with heavy paper between. Plank will not be needed unless teams are to be driven upon this floor, two thicknesses of boards being strong enough for all other purposes. Quicker and easier storing can be done if the load is drawn from the field to the floor hatchways. The under side of the floor timbers can be covered with matched sheathing, giving a dead air space between.

No litter of any kind is required on the floor above, even in coldest weather, if construction work is properly done. Such a cellar will keep an even temperature of 35 to 37 degrees during winter and warm up very slowly in the spring if kept closed, bringing the potatoes out in the best possible condition for either market or seed purposes.

Experience proves that a dry, cool cellar will cause shrinkage, while a damp, cool cellar will keep the tubers as firm and hard as when dug, with little waste from shrinkage. When storing in the fall, the cellar should be cooled down to from 30 to 40 degrees above zero. This can be hastened by opening the doors at night, when the outside temperature is lower than that of the cellar, and closing in the morning, repeating this until the temperature of the cellar is about 36 degrees above zero.

MARKETING THE CROP.—This is largely a matter of color, size and quality. As a rule, the markets of today demand a somewhat round, white potato, with a shallow eye. These should be well sorted and graded as to size. Uniformity of size attracts the buyer. There

should always be at least two grades, and if there are many large tubers of a pound or more in weight, it is usually advisable to make three grades, the first nice, smooth tubers, practically free from scab, prongs or any form of roughness. The largest should not be much, if any, over 12 to 14 ounces, and the smallest not below 5 ounces. This is as great a variation in size as ought to exist in any lot which the grower expects to be graded as firsts and bring the highest price.

All above this grade in size that are good and smooth will usually sell for a higher price per bushel than could be obtained if both of these grades were mixed together. There is invariably a good market for these large tubers if smooth and nice in appearance and good, clear through. The fear that they are hollow and black in the center or core is about the only objection the buyer has to them; but they have in their favor large size, which readily commends them to the maker of potato chips or the hotels or restaurants where fried potatoes are served, large tubers being peeled with less labor and waste. Could nice, clean stock, running from 12 ounces to two pounds always be obtained, there would be a good demand for it at good prices. The third grade will be all below five ounces in weight down to those the size of large hen's eggs, all being good and smooth. This grade is preferred for baking purposes, as they bake quickly and the flavor is equal to any.

The ordinary grower does not have enough of either of the last two grades to establish and maintain a trade in them, and in the average neighborhood there are so many different varieties grown that co-operative work is impossible. Potatoes graded in this way will yield growers more money and better satisfy the consumer.

STORE HOUSE

Where potatoes are largely grown co-operative organization should exist among growers, not only in marketing the crop, but in the purchase of seed. Such organizations should possess buildings of ample size, with railroad siding facilities. Growers should handle their crops there and an expert corps of men be employed to sort and grade them. The cost would perhaps be a little more than grading in the field, but the extra price obtained would more than offset the extra cost, as field-sorted stock is never properly graded. By this method the graders, having no interest in any particular lot, would grade uniformly. Grading is essential to create a reputation and secure highest prices. With such an organization, varieties planted can be limited to those best suited to the locality as to quality, yield and market demands. The locality which can establish and maintain a reputation for choice well-graded stock, not only obtains the highest price at all times, but its product is demanded even when a glut depresses the market. This is of value to the grower, enabling him to dig and dispose of his crop at good prices, even in overstocked seasons.

Prices obtained by Long Island, N. Y., growers well illustrate this point, they frequently obtaining from fifty cents to one dollar per barrel above the general market. Returns are increased ten to fifteen per cent., under proper co-operation, upon the lines suggested.